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THE GENUS RHAGOLETIS LOEW SOUTH OF THE UNITED STATES (DIPTERA: TEPHRITIDAE)

ORIGINAL

UNITED STATES DEPARTMENT OF AGRICULTURE

TECHNICAL BULLETIN NUMBER 1607

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ABSTRACT

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The known species of the genus Rhagoletis Loew occurring in Mexico, Central America, the West Indies, and South America are treated in this revisionary work. A key to the 7 species groups and 21 species is presented. The discussion of each group gives a taxonomic diagnosis and information about its overall distribution, including a map, and its composition in terms of species. Each species discussion includes a taxonomic diagnosis, a more complete taxonomic description if not well known, and a discussion of its taxonomic relationships and economic importance. Diagnostic characters, including the ovipositor and wing pattern of each species except R. metallica, are illustrated. R. tomatis, R. penela, R. jamaicensis, and R. adusta are described as new species. For the first time, R. nova, R. psalida, R. striatella, and R. ferruginea are shown to have species so closely related that they are made the name bearers of species groups. The name Ortalis ochraspis Wiedemann is shown to be a nomen dubium and is not to be used for the present. Two of the species in the nova group, R. lycopersella Smyth and R. tomatis, n. sp., are of economic importance in Peru and Chile. A third species, R. striatella Wulp, is a pest of considerable economic importance on commercial plantings of the husk-tomato (Physalis spp.) in Mexico, where it is extensively used for cooking. Certain other species have potential or actual economic significance elsewhere.

KEYWORDS: America south of the United States, biology, Diptera, economic importance, neotropical region, Rhagoletis, taxonomy, Tephritidae.

THE GENUS RHAGOLETIS LOEW SOUTH OF THE UNITED STATES (DIPTERA: TEPHRITIDAE)

By
Richard H. Foote

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CONTENTS

	Page
Morphology	2
Host relationships	5
Key to species groups and *Rhagoletis* species	9
Ortalis ochraspis Wiedemann, nomen dubium	11
Rhagoletis nova group	13
Rhagoletis lycopersella Smyth	15
Rhagoletis tomatis, new species	18
Rhagoletis nova (Schiner)	20
Rhagoletis conversa (Brèthes)	22
Rhagoletis willinki Aczél	24
Rhagoletis penela, new species	26
Rhagoletis psalida group	27
Rhagoletis psalida Hendel	28
Rhagoletis rhytida Hendel	31
Rhagoletis metallica Hendel	33
Rhagoletis striatella group	34
Rhagoletis striatella Wulp	34
Rhagoletis macquartii (Loew)	37
Rhagoletis jamaicensis, new species	39
Rhagoletis ferruginea group	41
Rhagoletis ferruginea Hendel	41
Rhagoletis adusta, new species	45
Rhagoletis blanchardi Aczél	46
Rhagoletis cingulata group	48
Rhagoletis cingulata (Loew)	48
Rhagoletis pomonella group	50
Rhagoletis pomonella (Walsh)	51
Rhagoletis suavis group	52
Rhagoletis completa Cresson	55
Rhagoletis juglandis Cresson	55
Rhagoletis zoqui Bush	56
Rhagoletis boycei Cresson	57
Literature cited	58
Index to insect and plant names	74

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THE GENUS RHAGOLETIS LOEW SOUTH OF THE UNITED STATES

(DIPTERA: TEPHRITIDAE)

By Richard H. Foote, research entomologist[1/]

In the United States and Canada, the genus Rhagoletis is of prime economic importance, and a great deal of information on its origin, phylogeny, biology, taxonomy, economic importance, and control has been published. For example, Rivard (1968)[2/] included 1,513 citations to pomonella (Walsh) alone in her bibliography, which is reasonably complete up to November 1968. Since then, investigations on pomonella and several other species have been continued by workers interested primarily in systematic relationships and behavior. The most comprehensive review of the nearctic species was by Bush (1966), whose work cannot be ignored by any serious student of the genus. After many years of morphological studies by many taxonomists, Bush introduced modern concepts of biosystematics, notably studies on food plant relationships, genetics, distribution, and behavior, into the study of the genus. This new approach to the study of Rhagoletis species has brought us much closer to actuality and at the same time has opened many new avenues for investigation of these flies.

On the other hand, the neotropical species of Rhagoletis have continued to be poorly understood, principally through lack of study. Originally my interest in these flies was awakened by the economic problems caused by Rhagoletis "ochraspis" in Peru and Chile, where an apparent complex of host races showed a mixed ability to infest cultivated tomatoes in irrigated areas along the western coast of South America. Armed with Smyth's description of Peruvian lycopersella (1960), a species having a wild tomato host but capable of badly damaging cultivated tomatoes close by, and with a series of study collections from various parts of Peru and Chile farther to the south, I have drawn a new and hopefully more realistic picture of this complex by following some of the leads given by Bush in his 1966 work. The details of this situation will be found here in the discussions of the nova group and its species.

A further consequence of my study is the discovery that species of Rhagoletis in the neotropical region can be aggregated into meaningful species groups. Thus, psalida Hendel and two additional species form a group inhabiting the altiplano of South America; striatella Wulp, discussed by Bush as a "miscellaneous species," proves to resemble two other similar but widely separated neotropical species; and two species in Bolivia, Argentina, and Brazil closely resemble ferruginea Hendel in many ways. The nearctic groups dis-

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[2/]The underlined year in parentheses indicates the reference in Literature Cited, p. 58.

cussed by Bush (i.e., cingulata, pomonella, and suavis) that occur in Mexico and a little farther south have also been included in this study, but little new information about them has been forthcoming.

To anyone studying this genus in the neotropical region, there are two drawbacks. One is the paucity of material available through ordinary collecting methods. For instance, despite extensive borrowing from institutional and personal collections all over Central and South America as well as in the United States, I have not encountered any specimens of Rhagoletis from Venezuela, the Guianas, or the northern half of Brazil and only occasional examples from the remaining parts of the neotropical region except Chile, where an intensive rearing and collecting effort was once made. The other obstacle, especially to those hoping to apply a biological species concept to their work, is the lack of information accompanying specimens or published in the literature about host relationships and behavior. For these reasons, my own approach has been principally morphological, although it is extremely gratifying to note that some of my conclusions based on morphology have been confirmed and strengthed by information about biology whenever it was available.

I hope that this study will reveal the kind and extent of investigations required to bring our knowledge of this genus to the level achieved by Bush for the nearctic species.

MORPHOLOGY

Bush (1966) briefly diagnosed and described in detail the Rhagoletis genus based on the nearctic species. A few taxonomic characters of the specimens seen in this study differ somewhat from his descriptions, or they slightly expand his concept of the genus. These qualifying features are discussed here, with an evaluation of each as a taxonomic character.

Head.--Few features of the head offer discriminating characters at the species or group level. The yellow or black postocellars and genal setulae appear to be species specific. In a few species the gena is rather wide, in a few others the eye appears to have a straight or concave posterolateral margin in profile, in still others the face may be bowed outward beneath the antennae, and in a few the third antennal segment is perfectly rounded apically. None of these characters appears to be congruous at the species-group level.

Scutum.--A character useful in distinguishing among species is the integumental pattern. It usually consists of four longitudinal bands of tomentum, which contrast well with the usually black or dark-brown integument when observed from slightly above and well behind the specimen so the light is reflected by them at a very low angle of incidence. These tomentose bands may be entirely separated from each other, or all fused anterior to the transverse suture, or the two on each side of the midline may be fused to each other but not to the other pair across the midline. The bands are distinctly separated from each other posterior to the transverse suture in all species that show the pattern, and the width of the dark areas between the bands appears to be diagnostic at the species level. The scutal pattern is present in all the species groups studied except the psalida and suavis groups, even in the brownish ferruginea and its immediate relatives, and it has been illustrated (figs.

12-24) for most of the species studied here. R. psalida is the only species in this study in which the scutal setulae form a distinct pattern (fig. 18).

Leg color.--The tarsi of all legs in these species are yellow, as are usually the foretibia and midtibia. The femora show various degrees of darkening from near the base toward the apex, usually with the apex left yellow. This darkening is rather variable, although a detailed study will probably show some statistically significant differences among species. Table 1 summarizes the approximate amount of darkening of the legs in the four species of the nova group, which had the largest number of available specimens.

Wing and wing pattern.--The wings of all species except those of metallica Hendel are shown in figures 71-93. The venation, shape, and relation of length to width are remarkably uniform throughout the genus except where the accessory costal spot is missing and an anterior extension of crossvein dm-cu intersects cell R1 halfway between the apices of veins R1 and R2+3 (fig. 91). Otherwise, vein dm-cu points to a spot in cell R1 much farther apicad. In most of the Rhagoletis species south of Mexico, vein R4+5 is prominently haired almost to vein dm-cu. The characteristic three transverse bands and the nature of the two apical bands show interesting specific and group differences, which are used extensively in this study. The names of the wing bands used throughout this publication are shown in figure 71.

Abdomen.--As in most North American species of Rhagoletis, abdominal tergites II-IV of males and II-V of females of all but three neotropical representatives have yellowish-to-white transverse marginal fasciae. These fasciae are present and usually easily visible, even in the brown-bodied species of the ferruginea group and some species of the suavis group.

Ovipositor.--The ovipositors of nearly all the species seen in this study are illustrated (figs. 28-43) to demonstrate the variation within the genus and at the same time to show the characteristics they share in common. The ovipositors of all the species have a central brownish area with paired points directed anteriorly, a feature I have not observed in other genera. Within limits it appears to be a useful character for species separation. An unusual feature is found within the nova group, where the tip has minute lateral subapical projections (figs. 14-17). Most characters seen in the ovipositor sheath and ovipositubus are diagnostically unreliable, as these parts do not always lie in comparable positions in slide mounts. However, the relative lengths of the sheath, ovipositubus, and ovipositor appear to be species specific at least in the ferruginea group (figs. 44-46) and perhaps in others.

Spermatheca.--This structure has two distinct forms in neotropical Rhagoletis. A rodlike form covered with scalelike papillae, as shown in figure 47, is characteristic of all groups except the striatella and ferruginea groups. In these two groups, the spermatheca is spherical (fig. 50), with the papillae clustered basally or apically. The spermatheca does not offer differentiating characters at the species level.

Male genitalia.--Although I have not exhaustively studied these features, it is immediately evident that for the most part the glans of the aedeagus is the most distinctive component, especially in the nature of the transparent capsule and its apical termination, as shown graphically by Bush (1966). In

TABLE 1.--Approximate amount of femora and tibiae darkened in 4 Rhagoletis species of the nova group[1/]

Item	lycopersella	tomatis	nova	conversa
	Percent	Percent	Percent	Percent
Forefemur:				
Minimum	80	70	0	60
Maximum	90	90	90	100
Average	90 (11)	80 (60)	50 (76)	90 (28)
Foretibia:				
Minimum	0	0	0	0
Maximum	0	0	0	0
Average	0 (11)	0 (60)	0 (93)	0 (28)
Midfemur:				
Minimum	80	60	0	50
Maximum	90	90	80	80
Average	90 (11)	80 (62)	40 (97)	70 (28)
Midtibia:				
Minimum	0	0	0	0
Maximum	0	0	0	0
Average	0 (10)	0 (60)	0 (100)	0 (28)
Hindfemur:				
Minimum	90	70	30	70
Maximum	90	90	90	90
Average	90 (11)	80 (62)	80 (90)	90 (28)
Hindtibia:				
Minimum	70	30	40	70
Maximum	90	90	90	90
Average	80 (11)	70 (60)	80 (95	80 (28)

[1/]Numbers in parentheses indicate pairs measured.

this respect and in the characteristics of the sperm pump apodeme and position of the prensisetae on the surstylus, the differences are mainly at the group, not the species, level. These differences are shown in figures 54-70 and are given in the diagnosis for each species group discussed in this study.

HOST RELATIONSHIPS

Where true hosts are known, either through data accompanying specimens seen during this study or recorded in the literature, most of the Rhagoletis species south of the United States utilize various genera and species of Solanaceae as primary food sources. This is particularly true of those groups containing species that are primarily neotropical in distribution, i.e., the nova, psalida, striatella, and ferruginea species groups. R. striatella itself occurs in the United States, but its only recorded host is Physalis species. Although ferruginea and very probably blanchardi Aczél of the ferruginea group have been recorded from Citrus, their native hosts are almost certainly species of wild Solanum or closely related genera.

On the other hand, the groups having primarily nearctic distribution and origin included in this study occur largely in other than solanaceous hosts. In Mexico, cingulata has at least once occurred in a Prunus species, pomonella has been found infesting Malus species and is suspected of occurring in this fruit in Colombia, and all members of the suavis group are widely known to occur in Juglans species. None of these nearctic species have been recorded from Solanaceae in Mexico. The one exception is found in striatella, already mentioned, which occurs as far north as Door County, Wis. In this instance, other species closely related to it occur in the neotropical region. Members of the cingulata, pomonella, and suavis species groups are strictly nearctic in distribution.

Table 2 summarizes the known hosts of the Rhagoletis species discussed in this study.

In the region studied, wild species of Solanaceae are numerous, some are widespread, and most of them are common in the dry areas. Nearly all bear small fruits, which are likely to harbor one to only a few larvae each, but these solanaceous plants probably offer a greater volume and continuity of oviposition sites to Rhagoletis than any other group of plants except in commercial orchards and similar concentrations of fruit. It is not surprising, then, that neotropical Rhagoletis species have become so widely adapted to this plant family, and that Rhagoletis is reported to be of economic importance in South America only where commercial solanaceous plants are grown near wild reservoirs. (See discussion of nova group.)

TABLE 2.--Summary of host information for *Rhagoletis* species south of Texas and Florida [1/]

Group and species	Host		Location	Source
	Scientific name	Common name		
R. nova group:				
lycopersella Smyth--	*Lycopersicon pimpinellifolium* (L.) Mill.	Currant tomato----	Peru---------	Smyth (1960), (2/).
	L. esculentum Mill.--------	Cultivated tomato, tomate.	---do--------	Smyth (1960), (2/).
tomatis, n. sp.------	*Lycopersicon esculentum* Mill.	-----do----------	Peru, Chile--	(2/).
nova (Schiner)-------	*Solanum muricatum* Ait.-----	Sweet cucumber, pepino, pepino dulce.	Chile--------	(2/).
conversa (Brèthes)---	*Physalis* sp.--------------	Husk-tomato, tomatillo.	---do--------	(2/).
willinki Aczél------	Not known----------			
penela, n. sp.-------	-----do----------			
R. psalida group:				
psalida Hendel-------	*Solanum tuberosum* L.-------	Potato (in fruits).	Peru---------	Munro (1968), (2/).
rhytida Hendel------	Not known----------			
metallica Hendel-----	-----do----------			
R. striatella group:				
striatella Wulp------	*Physalis* spp.-------------	Husk-tomato-------	Mexico-------	Bush (1966), Wasbauer (1972), Anon. (1975).
macquartii (Loew)----	Not known----------			
jamaicensis, n. sp.--	-----do----------			

See footnote at end of table.

TABLE 2.--Summary of host information for *Rhagoletis* species south of Texas and Florida[1/]--Continued

Group and species	Host		Location	Source
	Scientific name	Common name		
R. ferruginea group:				
ferruginea Hendel----	*Citrus sinensis* (L.) Osb.	Laranja----------	Brazil-------	d'Araújo e Silva et al. (1968), Lima (1938).
	Solanum spp.----------	Joá----------	---do--------	d'Araújo e Silva et al. (1968).
adusta, n. sp.-------	Not known----------			
blanchardi Aczél-----	*Citrus aurantium* L.--------	Sour orange-------	Argentina----	Aczél (1954).
	Citrus sp.----------	Orange----------	---do--------	(2/).
R. cingulata group:				
cingulata (Loew)-----	*Prunus serotina* subsp. *capuli* (Cav. ex Spreng.) McVaugh.	Capulin----------	Mexico-------	Padilla (1964).
R. pomonella group:				
pomonella (Walsh)----	*Crataegus* spp.----------	Hawthorn----------	---do--------	Bush (1966).
	Crataegus spp.----------	Tejocote----------	---do--------	Anon. (1975), (2/).
	Malus sylvestris Mill.-----	Apple----------	---do--------	Bush (1966).
Probably *pomonella*---	*Malus sylvestris* Mill.-----	Manzano----------	Colombia-----	Carlos and Luis (1947).
R. suavis group:				
completa Cresson-----	*Juglans* sp.----------	Walnut----------	U.S., Mexico.	Bush (1966).
	Juglans hirsuta Manning----	-----do----------	---do--------	Berlocher (in litt.).
juglandis Cresson----	*Juglans major* (Torr.) Heller.	-----do----------	---do--------	Bush (1966).

See footnote at end of table.

TABLE 2.--Summary of host information for *Rhagoletis* species south of Texas and Florida[1/]--Continued

Group and species	Host		Location	Source
	Scientific name	Common name		
zoqui Bush----------	*Juglans mollis* Engelm.-----	Nogal, nogal encarcelada, nuez meca, nuez pecanero.	Mexico-------	Bush (1966), Anon. (1975).
boycei Cresson-------	*Juglans* sp.----------	Walnut----------	U.S., Mexico.	Bush (1966).

[1/]Only those hosts recorded or known south of the United States are reported here. For more detailed treatment of hosts of nearctic species, see Bush (1966) and Wasbauer (1972).

[2/]Data accompanying specimens examined during this study.

KEY TO SPECIES GROUPS AND RHAGOLETIS SPECIES

1. Thorax and abdomen predominantly black with yellow markings; scutellum black at base and sides, yellow at apex, or completely black---------- 2
   Thorax and abdomen predominantly brown to yellow; scutellum concolorous cream color, sometimes with very narrow dark band at base---------- 16
2. Scutum with integumental pattern of 2 to 4 longitudinal tomentose bars which are often connected to each other anterior to transverse suture, or scutum almost entirely tomentose; scutellum black at base and sides, yellow apically ---------- 3
   Scutum and scutellum entirely black, scutum without tomentose pattern of bars (fig. 18); Bolivia, Peru, Ecuador, ?Venezuela; psalida group---------- 9
3. Accessory costal bar of wing pattern present between discal and subapical wing bands; nova group---------- 4
   Accessory costal bar between these 2 long wing bands absent-------- 11
4. Discal band of wing pattern wider than hyaline fascia immediately proximal to it (figs. 77, 78); ovipositor tip with minute subapical lateral projections (figs. 32, 33)---------- 5
   Discal band of wing pattern distinctly narrower than hyaline area proximal to it (figs. 72-76); ovipositor tip simple or with subapical lateral projections---------- 6
5. Anterior apical band of wing pattern broken by narrow hyaline fascia at apex of vein R4+5 (fig. 77)----------willinki Aczél
   Anterior apical band of wing pattern complete (fig. 78)-----penela, n. sp.
6. Anterior apical band of wing pattern complete, not narrowed or broken near its base by hyaline area; ovipositor tip simple, without lateral subapical projections (figs. 28, 29)---------- 7
   Anterior apical band of wing pattern narrowed or completely interrupted near its base by anterior extension of hyaline area behind it (figs. 74, 75); ovipositor tip with minute lateral subapical projections (figs. 30, 31)---------- 8
7. None of longitudinal bars of tomentose scutal pattern connected; lateral bars usually not extending anterior to transverse suture (fig. 12); posterior apical arm of wing pattern represented by dark spot on vein AM (fig. 72)----------lycopersella Smyth
   Two bars of scutal pattern on each side of midline connected to each other anterior to transverse suture (fig. 13); dark spot on vein AM usually absent, or posterior apical band represented by clouding on either side of vein AM in this position (fig.73)----------tomatis, n. sp.
8. All 4 bands of tomentose scutal pattern connected to each other anterior to transverse suture (fig. 14); discal band of wing pattern widest at crossvein r-m (figs. 74, 75); postocellar bristles yellow----------nova (Schiner)
   Scutal pattern with none of 4 longitudinal bands connected anterior to transverse suture (fig. 15); discal band of wing pattern parallel-sided (fig. 76); postocellar bristles black--conversa (Brèthes)

9. Scutum adorned with long, stout, golden-to-yellow setulae in distinct pattern (fig. 18); anterior apical band of wing pattern broadly united to preapical band, cell R3 almost completely dark at their junction (figs. 79, 80); dorsal surface of scutellum evenly convex----------psalida Hendel

Scutal setulae evenly distributed, not forming distinct pattern; anterior apical band of wing pattern narrowed at its junction with preapical band, or represented only by a spot at apex of vein R4+5 (fig. 81); at least basal part of scutellum flat------- 10

10. Basal half of dorsum of scutellum flat, with longitudinal wrinkles; abdominal tergites II-IV of male and II-V of female with narrow yellowish transverse marginal fasciae----------rhytida Hendel

Entire dorsal surface of scutellum flat, smooth; abdominal tergum entirely black, without transverse marginal fasciae on tergite margins----------metallica Hendel

11. Posterior apical band of wing pattern represented by very narrow dark fascia lying on apical two-thirds of vein M between apex and vein dm-cu (fig. 93); U.S., Mexico; suavis group (part)---boycei Cresson

Posterior apical band wide, complete, crossing vein M diagonally, or completely absent (fig. 89)---------- 12

12. Anterior apical band of wing pattern separated from costa along most of its length; discal and subapical bands united (fig. 89); capitate part of halter dark, basal part white; U.S., Mexico, ?Colombia; pomonella group----------pomonella (Walsh)

Anterior apical band of wing pattern contiguous with costa along entire length; 3 separate transverse bands present in wing pattern; halter unicolorous yellow to white---------- 13

13. Anterior apical bar forked apically, or anterior part of fork broken to form spot at apex of vein R4+5 (fig. 88); spermatheca rodlike; Mexico; cingulata group----------cingulata (Loew)

Anterior and posterior apical bars of wing pattern present and complete; spermatheca spherical (fig. 82); U.S., Mexico, Costa Rica, Jamaica, Brazil; striatella group---------- 14

14. Tomentose scutal pattern with 1 wide longitudinal bar on each side of midline, each bar divided longitudinally by narrow black line (fig. 19); subbasal and discal bands of wing pattern completely separated from each other (fig. 82); ovipositor long, with swelling subapically (fig. 36)----------striatella Wulp

Tomentose scutal pattern with 4 bars, 2 on each side of centerline separated by fasciae as wide as 1 of the bars (figs. 20, 21); subbasal and discal bands of wing pattern close to each other, sometimes fused (figs. 83, 84); ovipositor short, without subapical swelling---------- 15

15. Subbasal and discal bands of wing pattern fused along most of their length (fig. 83); all bars of tomentose scutal pattern separate, not fused anterior to transverse suture (fig. 20)------macquartii (Loew)

Subbasal and discal bands of wing pattern situated very close to each other but joined only in cell R (fig. 84); 2 lateral bands of tomentose scutal pattern joined to each other anterior to transverse suture (fig. 21)----------jamaicensis, n. sp.

16. Tomentose scutal pattern present, consisting of 4 to 6 longitudinal bars; accessory costal bar of wing pattern present; spermatheca spherical (fig. 53); Bolivia, Argentina, Brazil; ferruginea group ---------- 17

Scutum without trace of tomentose pattern; accessory costal bar absent (figs. 90-92); spermatheca rodlike; U.S., Mexico; suavis group (part)---------- 19

17. Abdominal tergites yellowish brown, last 2 in each sex with dark-brown-to-black spots laterally; anterior apical band of wing pattern narrower than hyaline fascia immediately posterior to it (fig. 85)----------ferruginea Hendel

Abdominal tergites dark brown to black with yellowish posterior margins; anterior apical band of wing pattern as wide as hyaline fascia immediately posterior to it (figs. 86, 87)---------- 18

18. Subapical band of wing pattern no wider between 2 apical bands than posterior to them (fig. 86); hindtibia darkened subbasally and subapically----------adusta, n. sp.

Subapical band of wing pattern distinctly wider between 2 apical bands than posterior to them (fig. 87); hindtibia with only darkened subapical area----------blanchardi Aczél

19. Anterior apical band of wing pattern complete, not at all narrowed at its junction with preapical band----------completa Cresson

Anterior apical band narrowed or broken at its junction with subapical band---------- 20

20. Subbasal transverse band of wing pattern absent, represented only by a yellowed area in basal 0.25 of wing disk (fig. 91)---------- ----------juglandis Cresson

Subbasal band of wing pattern present, distinct (fig. 92)-------zoqui Bush

ORTALIS OCHRASPIS WIEDEMANN, NOMEN DUBIUM

Ortalis ochraspis Wiedemann 1830: 466. Type-locality, Brazil.

Discussion.--The types of several names in succession, including that of ochraspis (Wiedemann, 1830, pp. 463, 467), are missing from the list published by Zimsen (1954). They are among the 42 types that she stated should be in Copenhagen but have never been found. A group of specimens, including the ochraspis male, is widely assumed to have been mislaid or "more likely destroyed" (Crosskey, in litt.). In view of this situation, I take the type-specimen to be no longer in existence and the name ochraspis to be a nomen dubium. It is amply evident from the following discussion that so far I have not been able to identify any specimens that might belong to the species named ochraspis by Wiedemann and that designating a neotype at this time is not feasible. Therefore the name has not been applied to any of the material before me, nor should it be until one can closer approximate the true nature of Wiedemann's species through future studies.

Wiedemann indicated that his specimen, with the sole designation "aus Brasilien," was "von Dr. Lund." According to Papavero's informative account (1971), P. W. Lund, a Danish physician, took up residence in Brazil in 1825 in search of a mild climate to relieve a pulmonary disorder and to place himself

among more promising ecological habitats in which to conduct his natural history studies. In 1829, he returned temporarily to Denmark, where he presented part of his collection of Brazilian insects to the then Museum of Natural History of Copenhagen, and thus gave Wiedemann the opportunity to study them. Between 1825 and 1829, Lund resided successively in Rio de Janeiro, in Niterói opposite Rio across the Bay of Guanabara, again in Rio, then on a farm near Nova Friburgo, where Papavero said he "assembled an important collection of insects and plants." He also made trips to Campos, São Fidélis, and to the border of Minas Gerais through the Serra dos Orgãos and the Rio Paraíba.

Quite likely, then, the type-locality of ochraspis seems to be in or near Nova Friburgo, only about 200 km northwest of Rio de Janeiro, or not much more than twice that because of the separate trips he made from Nova Friburgo.

Wiedemann's description of the male specimen he named ochraspis indicates that it had a blackish body with a bright yellow pleural stripe between the humerus and wing base and a yellow scutellum with a black base. The wing is described as having three distinct transverse brown bands, two well-developed apical bands, and an accessory costal spot. The foretibia, midtibia, and tarsi were yellow, and all the femora and hindtibia were blackish, especially on the external surfaces. The accessory costal spot of the wing pattern noted by Wiedemann is present only in the nova, psalida, and ferruginea groups seen in this study; the psalida group is a high-altitude complex with a completely black scutellum; and the ferruginea group comprises species with brown rather than black bodies. Thus, of the seven species groups discussed here, Wiedemann's description conforms most closely to the diagnosis of the nova group as given here.

Within the nova group, the ochraspis male must have resembled willinki most closely because of its extensively darkened forefemur and the characteristic anterior apical band of the wing pattern. However, the tergites of the former were said to have transverse marginal fasciae, which are absent in willinki, and the type-localities of the two species (i.e., known ranges) are not only far removed from each other but offer different ecological habitats. It is interesting to note that during this study I found no members of the nova group that occurred west of extreme western Argentina; all the species of this group occur in Chile and Peru, as far as known, with the exception of willinki, which is known only from Neuquén territory, Argentina. This leaves a very large, extremely rich area of Brazil from which I have seen no Rhagoletis species except two species of the ferruginea group, ferruginea and adusta. Except for these two species, either the genus must not be common in this part of Brazil or optimum collecting techniques have never been used.

It is clearly evident that many subsequent references to ochraspis are in gross error through carelessness, lack of sufficient study, or both. I list here all literature that is clearly not referable to other taxa at the species-group level given in this study.

Rhagoletis ochraspis (Wiedemann):
Wulp 1899: 409 (brief description).
Bezzi 1910: 15 (in key, American species); 19 (taxonomic note).
Hendel 1914: 29 (in key, neotropical species; in neotropical catalog).

Malloch 1933: 265 (description, taxonomic discussion). Refers to one of two species in the nova group.
Kisliuk and Cooley 1933: 240 (economic importance, hosts). Probably one of the nova group species.
Wille 1940: 382 (economic importance). Probably either lycopersella or tomatis, n. sp.
Hering 1941: 141 (in key, Peruvian species); 142 (description, taxonomic discussion). Refers to one of the nova group species.
Wille 1943: 289 (economic importance). One of the nova group species.
Aczél 1949: 239 (in neotropical catalog). May refer to any of the neotropical species.
Fauré 1958: 15 (biology, economic importance). Possibly tomatis, n. sp.
Foote 1967: 57.41 (in neotropical catalog). Refers only to Wiedemann's description, listed as "unrecognised."

RHAGOLETIS NOVA GROUP

Diagnosis.--Thorax and abdomen black with yellow markings; postocellars black or yellow; scutum with integumental pattern of 4 longitudinal bars; scutellum yellow with black base and sides; legs yellow, femora with extensive black markings; wing pattern with 3 separate transverse bands, basalmost 2 united in 1 species; anterior apical band complete to broken; posterior apical band incomplete, represented only by a spot, or completely absent; accessory costal bar present; abdominal tergites with yellowish transverse marginal fasciae except in 2 species; apical process of glans haired, tunica bare; spermatheca rodlike.

Discussion.--In the late 1950's, Olalquiaga-Fauré (Fauré, 1958) pointed to a problem concerning Rhagoletis species on cultivated tomatoes in Chile, expressing the desirability of exporting tomatoes to the United States but at the same time indicating that at least two "strains" of "ochraspis" were involved and that there were no ready means of distinguishing between them morphologically. L. Caltagirone in 1961 (pers. commun.) reiterated this uncertainty by pointing out that flies collected at Copiapó (about 27° N. lat.) had been reared from cultivated tomato, but that at La Cruz, situated at close to 33° N. latitude, similar appearing flies infested Solanum muricatum Ait. and could not be induced to use cultivated tomatoes as a food plant.

Subsequently, I received numerous specimens collected from various localities in Chile through the courtesy of L. Caltagirone, R. Cortes, and L. Campos (see acknowledgments). A detailed study of this material has led to the discovery of four distinct species--lycopersella Smyth, tomatis, n. sp., conversa (Brèthes), and nova (Schiner)--all of which at one time or another have been called "ochraspis" and which have been suspect in causing economically important damage to cultivated tomatoes in Chile. These four species are in addition to two others belonging to the nova group--willinki Aczél and penela, n. sp.--which are discussed here.

It is interesting to note that not only do lycopersella and tomatis resemble each other more closely than any of the other nova group species but also that they are the only Rhagoletis species in Peru and Chile that attack cultivated tomatoes. Their distribution (map 1) appears to be allopatric in that lycopersella occurs only in the vicinity of Lima northward, whereas tomatis

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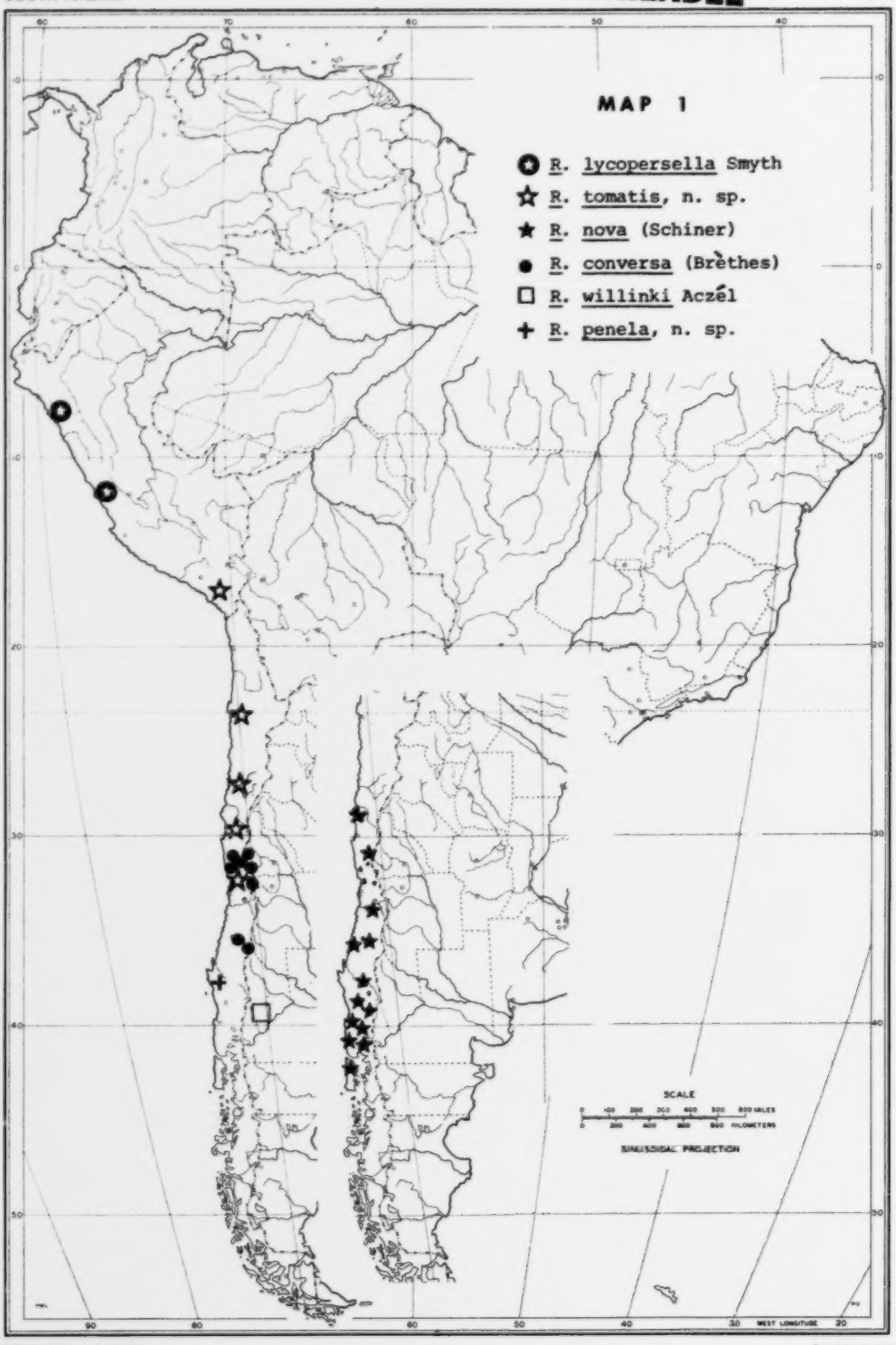

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occurs from Moquequa in southern Peru to and including the Valparaiso area. A wild tomato, Lycopersicon pimpinellifolium (L.) Mill., serves as a native host for lycopersella, but under certain conditions that species transfers easily to cultivated tomatoes (see discussion of lycopersella). Oddly enough, no native wild host has ever been recorded for tomatis; all the specimens seen in this study have been collected from tomate or cultivated tomato throughout its range.

Another species "pair" consists of nova and conversa, each markedly resembling the other morphologically. R. nova, the more common and widespread of the two species, occurs from the Valparaiso area southward to Chiloé Island (map 1) and has been collected only from Solanum muricatum, a plant called pepino or pepino dulce (sweet cucumber) in Chile. Repeated attempts to rear both nova and conversa on cultivated tomatoes have failed (Fauré, 1958). R. conversa is a relatively localized species separable from nova with some difficulty, but the differences between them certainly are of specific value.

A third species "pair" involved willinki and penela, the hosts of neither of which are known. The latter species occurs east of the Andean chain in a presumably different ecological situation and is the only member of the nova group not found in a coastal area in western South America.

Rhagoletis lycopersella Smyth

(Figs. 1, 12, 28, 54, 60, 66, 72; map 1)

Rhagoletis lycopersella Smyth 1960: 16 (description, life history, economic importance); figs. 1-3 (adult habitus, wing). Type-locality, Rio Chicama, near Trujillo, Peru.--Foote 1967: 57.41 (in neotropical catalog).--Boller and Prokopy 1976: 228 (life history notes).

Diagnosis.--Apex of third antennal segment rounded; postocellars black; thorax predominantly black; scutal pattern (fig. 12) consisting of 4 longitudinal bars completely separated from each other by black stripes, lateral bars visible only posterior to transverse suture; scutellum yellow with transverse basal black border which also extends posteriorly along sides; 0.8-0.9 (avg. 0.9) of forefemur and midfemur, 0.9 of hindfemur black; foretibia and midtibia yellow, 0.7-0.9 (avg. 0.8) of hindtibia black; all transverse wing bands fully complete (fig. 72); anterior apical band complete, not narrowed near base; posterior apical band represented by isolated but distinct dark spot on vein M; accessory costal spot present; posterior margins of abdominal tergites with narrow transverse yellow bands.

Description.--In profile, head about 1.5 times as high as long (fig. 1), gena about 0.2 times as high as eye; face prominent, easily visible and slightly bowed anteriorly in lateral view; antennal foveae deep, extending nearly to oral margin; frons yellow, nearly square; frontal, genal, and gular setulae black; all head bristles black, including postocellars; antenna yellow, about half as long as face; apex of third segment rounded apically, not drawn out to pointed projection; entire thickened base of arista yellow; occiput irregularly darkened above occipital foramen and laterally nearly to postoculars. Thorax predominantly black; yellow stripe between humerus and

wing base about 3 times as long as wide, upper anepisternal bristle in extreme posteroventral corner; scutal pattern (fig. 12) consisting of 4 longitudinal bars separated by longitudinal black stripes wider than any of the bars, lateral bars usually visible only behind transverse suture, although there may be a faint spot immediately anterior to suture on each side; scutal setulae black, separated from each other by less than their own length; scutellum with black band at scutoscutellar suture which projects laterally on each side. Legs yellow with black markings as follows: 0.8-0.9 (avg. 0.9) of forefemur and midfemur (table 1), 0.9 of hindfemur, 0.7-0.9 (avg. 0.8) of hindtibia; 1-3 preapical anteroventral bristles on hindfemur. Wing (fig. 72) with 4 well-developed transverse bands, discal band always widest at r-m crossvein; anterior apical band always complete, without narrowing at its point of attachment with subapical band; posterior apical band in nearly all specimens represented by distinct spot that lies on vein M; accessory costal spot present. Abdomen black, with yellow transverse stripes at posterior margins of tergites II-V in male and also of VI in female; ovipositor (fig. 28) with slender single point at tip, ratio of width to length about 0.13, sides with flat surfaces part way along length, internal projections ending about at midlength; appendix of aedeagus (fig. 54) about half again as long as main body, with distinct spinelike setulae; ejaculatory apodeme (fig. 60) almost half as wide as long; prensisetae (fig. 66) situated at about 0.6-0.7 of length of surstylus.

Material examined.--Cartavio, Peru, E. G. Smyth, (date not available), 11 ♂♂, 15 ♀♀ (USNM), 10 ♂♂, 5 ♀♀ (AMNH); 1 ♂, 2 ♀♀, Lima, Peru, J. E. Wille, (date not available) (USNM).[3/]

Discussion.--R. lycopersella shares with tomatis several characters (table 3), including black genal setulae anterior and posterior to the genal bristle, black postocellars, the anterior apical band of the wing pattern without any narrowing or interruption at its junction with the subapical band (figs. 72, 73), and the ovipositor tip simple and without minute subapical lateral projections (figs. 28, 29). The last two characters distinguish both these species from the other four species of the nova group. It may easily be distinguished from tomatis by the scutal pattern (fig. 12), which consists of four longitudinal bars completely and widely separated from each other anterior to the transverse suture; the lateral bars are usually not visible anterior to the suture except in an occasional specimen in which a small indistinct spot may be present immediately anterior to the suture in line with each lateral bar. In every specimen of lycopersella studied, the posterior apical band is represented by a distinct spot at the middle of the apical sector of vein M, whereas that of tomatis is rarely present (see discussion of tomatis).

Biology and economic importance.--Smyth (1960) recorded more completely than any other observer the life history and economic importance of lycopersel-

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[3/]U.S. National Museum, Washington, D.C. For explanation of other similar abbreviations, see under acknowledgments. Throughout this bulletin all information pertaining to material examined is given essentially as it appeared on the insect labels.

TABLE 3.--Differentiating morphological characters of species in *nova* group

Character	*lycopersella*	*tomatis*	*nova*	*conversa*	*willinki*	*penela*
Genal setulae	Black	Black	Yellow	Black and yellow.	Black	Black.
Postocellars	--do	--do	--do	Black	--do	Do.
Bars in scutal pattern.	None united	2 on each side united.	All united	None united	2 on each side united.	2 on each side united.
Abdominal tergites margined.	Yes	Yes	Yes	Yes	No	No.
Ovipositor tip	Single	Single	Tripartite	Tripartite	Tripartite	Tripartite.
Subbasal and discal bands.	Far apart	Far apart	Far apart	Far apart	Close together.	Close together.
Discal band	Narrowed	Narrowed	Narrowed	Parallel-sided.	Narrowed	Narrowed.
Anterior apical band.	Entire	Entire	Narrowed or broken.	Narrowed or broken.	Broken	Entire.
Posterior apical band (spot).	Present	Usually absent	Usually absent or obsolete.	Absent	Present	Present.

la. His account gives the only biological information we have about any of the members of the nova group. The females of lycopersella oviposit readily on cultivated tomatoes when they are grown near its native host, Lycopersicon pimpinellifolium, and under these circumstances the fruits of cultivated tomato are nearly 100 percent infested and rarely reach maturity. A factor also contributing to the potential of lycopersella as a pest species is its ability to aestivate in the pupal stage (Boller and Prokopy, 1976), probably because of the extremely dry conditions where it is found. Smyth indicated that some pupae were alive after 8 months of being kept in dry petri dishes in the laboratory, whereupon wetting caused the emergence of some adults. This situation could afford an opportunity for viable pupae to be hidden in straw or other materials used for packing fruit for shipment to locations outside Peru, where weather conditions could cause the liberation of new adults. Smyth's account should be consulted for the details of his observations on this potentially destructive fly.

Rhagoletis tomatis, new species

(Figs. 2, 13, 25, 29, 47, 55, 61, 73; map 1)

Rhagoletis ochraspis (Wiedemann): Kisliuk and Cooley 1933: 240 (collection notes).--Aczél 1954: 83; figs. 10-13 (head, abdominal tergum); pl. 1, B (wing).

Rhagoletis achraspis [sic] (Wiedemann): Aczél 1954: 77 (in key, neotropical species).

Diagnosis.--Apex of third antennal segment very bluntly pointed; postocellars black; thorax predominantly black; scutal pattern (fig. 13) consisting of 4 longitudinal bars, 2 on each side of midline distinctly united anterior to transverse suture, black stripe at midline distinctly wider than that between lateral bars; scutellum yellow with transverse basal black border which also extends posteriorly along sides; 0.7-0.9 (avg. 0.8) of forefemur black, 0.6-0.9 (avg. 0.8) of midfemur black, 0.9 of hindfemur black; foretibia and midtibia yellow, 0.3-0.9 (avg. 0.7) of hindtibia black; all transverse wing bands well developed (fig. 73); anterior apical band complete, not narrowed or interrupted at base; posterior apical band or spot usually absent; accessory costal spot present; posterior margins of abdominal tergites with narrow transverse yellow bands.

Description.--In profile, head about 1.4 times as high as long (fig. 2), gena about 0.2 times as high as eye; face prominent, easily visible and slightly bowed anteriorly in lateral view; antennal foveae deep, extending nearly to oral margin; frons yellow, nearly square; frontal, genal, and gular setulae black; all head bristles black, including postocellars; antenna yellow, about 0.6 times as long as face; apex of third segment bluntly pointed but not drawn out to pointed projection; entire thickened base of arista yellow; occiput irregularly darkened in lines and blotches above occipital foramen and laterally to postoculars. Thorax predominantly black; yellow stripe between humerus and wing base about 3 times as long as wide, upper anepisternal bristle well within yellow at posteroventral corner; scutal pattern (fig. 13) consisting of 4 longitudinal bars, 2 on each side of midline distinctly united anterior to transverse suture, black stripe at midline

distinctly wider than that between lateral bars; scutal setulae black, separated from each other by less than their own length; scutellum with black band at scutoscutellar suture which projects laterally on each side. Legs yellow with black markings as follows: 0.7-0.9 (avg. 0.8) of forefemur (table 1), 0.6-0.9 (avg. 0.8) of midfemur, 0.7-0.9 (avg. 0.8) of hindfemur, 0.3-0.9 (avg. 0.7) of hindtibia; 1-3 preapical anteroventral bristles on hindfemur. Wing (fig. 73) with 4 well-developed transverse bands, discal band always widest at r-m crossvein; anterior apical band always complete, without narrowing or interruption at its point of attachment with subapical band; posterior apical band usually missing entirely, but if present, it is represented by only obscure clouding in cells R5 and cell M on either side of vein M, never directly on vein M itself; accessory costal spot present. Abdomen black with yellow transverse stripes (fig. 25) at posterior margins of tergites II-V of male and II-VI of female; ovipositor (fig. 29) with slender single point at tip, ratio of width to length 1:10-1:15, sides with flat surfaces part way along length, internal projections ending about midlength; spermatheca as in figure 47; appendix of aedeagus (fig. 55) about half again as long as main body, with distinct spinelike setulae; ejaculatory apodeme (fig. 61) about half as wide as long; prensisetae situated at about distal 0.6-0.7 of surstylus.

Holotype.--Female, Copiapó, 11.V.1945, Alvarado, collector, USNM Type No. 75960.

Paratypes.--4 ♂♂, 2 ♀♀, nr. Moquequa, Peru, 26.III.1932, Kisliuk and Cooley, coll., swept from tomato, K & C No. 214 (USNM).

Additional material examined.--CHILE: 1 ♂, same data as holotype; 9 ♀♀, 7 ♂♂, Copiapó, 11.V.1945, Alvarado, coll., tomato; Antofagasta, Alvarado, coll., 1 ♂, V.1940, 2 ♂♂, 6.IV.1944, 2 ♀♀, 1 ♂, 5.IV.1945, 1 ♀, 4 ♂♂, 17.IV.1945, 2 ♀♀, 4 ♂♂, 8.IV.1945, 1 ♂, 9.IV.1945 (UCS) (USNM); 1 ♀, Antofagasta, 23.VIII.1940, P. A. Berry, USDA Lot No. 40-25219 (USNM); La Cruz, Valparaiso, 2.V.1963, J. Aranda, coll., 4 ♀♀, 4 ♂♂ (UCC), 4 ♀♀, 4 ♂♂ (USNM); 3 ♂♂, Vicuña, 21.V.1963, M. S. Rivas (FLB).

Discussion.--R. tomatis shares with lycopersella several characters, two of which distinguish both species from all others in the nova group (see table 3 and discussion of lycopersella), but it may be distinguished very easily from the latter species by the scutal pattern (fig. 13), in which the two longitudinal bars on each side of the midline are united with each other anterior to the transverse suture and leave a rather wide black median band distinctly uninterrupted from the base of the scutellum to the extreme anterior margin of the scutum. In lycopersella the posterior apical band is represented by a distinct spot in the apical section of vein M, whereas that of tomatis is usually missing. In a few specimens of the latter, indistinct clouding is evident in that area of the wing, never directly on the vein but in a small area in cell R5 anterior to vein M and a small area on cell M posterior to that vein.

This species is not likely to occur much farther south than shown in map 1, as it was not found among reasonably large collections of Rhagoletis in wild tomatoes in the Valparaiso area. However, its northern limits have not been determined with any degree of confidence as the coastal plain of Peru has not been explored in detail for species of the nova group.

Biology and economic importance.--Like lycopersella, tomatis attacks cultivated tomatoes, probably under much the same ecological conditions as the former. Although none of the material available for this study was collected from plants other than cultivated tomato, it would not be surprising to find that tomatis also has a native host to sustain its populations during extremely dry conditions. R. tomatis is undoubtedly the species of "ochraspis" to which Caltagirone referred in reporting a tomato-infesting Rhagoletis from Copiapó, Chile, indistinguishable from other species not inhabiting cultivated tomatoes farther to the south (see discussion of nova group).

Etymology.--The name tomatis is the Latinized genitive of tomate, the Spanish common name of the cultivated tomato.

Rhagoletis nova (Schiner)

(Figs. 3, 14, 30, 74, 75; map 1)

Spilographa nova Schiner 1868: 264. Type-locality, Chile.
Rhagoletis ochraspis (Wiedemann): Kisliuk and Cooley 1933: 239 (collection note).
Rhagoletis nova (Schiner): Hering 1941: 142 (description, taxonomic discussion).--Aczél 1949: 239 (in neotropical catalog).--Foote 1967: 57.41 (in neotropical catalog).
Rhagoletis ochrastis [sic] (Wiedemann): Hardy 1968: 140 (taxonomic discussion, types).

Diagnosis.--Apex of third antennal segment distinctly pointed; postocellars yellow; thorax predominantly black; scutal pattern (fig. 14) consisting of 4 longitudinal bars all united anterior to transverse suture, median and lateral black stripes separating them of about equal width; scutellum yellow with basal black border which also extends posteriorly along sides; forefemur completely yellow to 0.9 black (avg. 0.5), midfemur completely yellow to 0.8 black (avg. 0.4), hindfemur 0.3-0.9 (avg. 0.8) black; foretibia and midtibia yellow, 0.4-0.9 (avg. 0.8) of hindtibia black; all transverse wing bands fully complete (fig. 74); anterior apical band narrowed or completely interrupted by rounded extension of hyaline area posterior to it; posterior apical band represented at most by suggestion of spot or clouding on vein M, usually completely absent; accessory costal spot present; posterior margins of abdominal tergites with narrow transverse yellow bands.

Description.--In profile, head about 1.5 times as high as long (fig. 3), gena about 0.2 times as high as eye; only lower half of face visible in lateral view; antennal foveae deep, extending nearly to oral margin; frons only slightly longer than width at vertex; all head setulae yellow or brown; all head bristles black except postocellars, which are yellow; antenna yellow, about half as long as face; third segment drawn out to sharp point apically; thickened base of arista yellow only at base; occiput yellow or darkened in irregular lines or blotches directly behind postverticals. Thorax predominantly black; yellow stripe between humerus and wing base about 3 times as long as greatest width, sometimes distinctly wedge shaped, upper anepisternal bristle situated well into yellow area; scutal pattern (fig. 14) consisting of 4 longitudinal bars all united anterior to transverse suture, median and lateral

black stripes separating them of about equal width but distinctly narrower than light bars; scutal setulae yellow, separated from each other by about their own length; scutellum with black band at scutoscutellar suture which projects laterally on each side. Legs yellow with black markings as follows: 0-0.9 (avg. 0.5) of forefemur (table 1), 0-0.8 (avg. 0.4) of midfemur, 0.3-0.9 (avg. 0.8) of hindfemur, 0.4-0.9 (avg. 0.8) of hindtibia; 1-3 preapical anteroventral bristles on hindfemur. Wing (figs. 74, 75) with 4 well-developed transverse bands, discal band always widest at crossvein r-m; anterior apical band always narrowed or completely interrupted at its base by rounded extension of hyaline area posterior to it, subapical band often with small apically directed projection on vein R4+5; posterior apical band rarely present, if so, it is represented by only slight cloud of infuscation on vein M; accessory costal spot present. Abdomen black, with narrow yellow transverse stripes at posterior margins of tergites II-V in male and also of VI in female, each stripe a little wider at midline than laterally; ovipositor (fig. 30) with tip having pair of minute lateral projections, ratio of width to length ranging from 0.13 to 0.16, sides evenly rounded, internal projections ending at about basal 0.3; appendix of aedeagus about half again as long as main body, with distinct spinelike setulae; ejaculatory apodeme distinctly less than twice as long as wide; prensisetae situated at about 0.6-0.7 length of surstylus.

Material examined.--CHILE: 1 ♂, Almac, 12-23.IV.1966, R. H. González (UCR); 1 ♀, 1 ♂, Ancud, Chiloé I., 19-XII.1926, F. & M. Edwards (USNM); 1 ♀, Angol, 19.I.1927 (USNM); 2 ♂♂, Angol, 10.XI.1931, D. S. Bullock, K & C Chile No. 209 (USNM); 1 ♂, Boco, I.1952, J. Donoso, en pepino dulce (UCC); 1 ♀, Casa Pangue, Llanquihue, 4-10.XII.1926, F. & M. Edwards (USNM); 1 ♀, Con-Con, Valparaiso, 12.1.1960, L. Caltagirone, en Solanum muricatum; 2 ♀♀, 4 ♂♂, III.1959, N. Hichens, en Solanum muricatum; 4 ♀♀, 14.III.1960, L. Caltagirone, en Solanum muricatum; 1 ♀, 1 ♂, 29.IV.1959, Santa Cruz leg., s/pepino dulce; 1 ♀, 15.VIII.1959, Santa Cruz leg., ex larva (UCC, UCS, USNM); 1 ♀, Costa Nuble, Nogueche, 15-17.XII.1953, L. E. Peña (CNC); 3 ♀♀, 4 ♂♂, Curacautin, Malleco, II.1951, L. E. Peña (CNC); 1 ♂, Estero La Palma at Rio Teno, 6 km E Los Quenes, 35°01'S, 70°48'W, M. E. Irwin (USNM); 1 ♀, 1 ♂, La Cruz, Valparaiso, IV.1960, L. Caltagirone, en Solanum muricatum (UCC, USNM); 11 ♀♀, 2 ♂♂, 15.IV.1961, L. Campos, reared ex Solanum muricatum (UCS, USNM); 1 ♀, 4 ♂♂, 2.V.1963, J. Aranda R., pepino dulce (USNM); 1 ♀, Los Andes, Aconcagua, VII.1944, Ramirez leg. (USNM); 1 ♀, Portezuelo, Valparaiso, 15.IX.1960, N. Hichens (UCS); 1 ♀, 5 ♂♂, Pucatrihue, Osorno, 40°28'S, 73°43'W, sea level, 4.II.1967, E. I. Schlinger (UCR); 1 ♀, 10 mi NE Pucon, 12.I.1951, Ross & Michelbacher (CAS); 1 ♀, Puerto Cisnes, Aysen, 44°45'S, 72°40'W, 16-28.II.1961, L. E. Peña (USNM); 1 ♀, 1 ♂, Putaendo, Aconcagua, 30.I.1959, Olalquiaga leg. (UCS, USNM); 2 ♀♀, 7 ♂♂, 20 km E Puyehue, 26.I.1951, Ross & Michelbacher (CAS, USNM); 5 ♂♂, same data but 28.I.1951 (CAS, USNM); Quebrada de la Plata, Rinconada Maipú, 33°31'S, 70°47'W, 550 m, malaise, M. E. Irwin, 3 ♂♂, 17.XI.1966, 3 ♀♀, 14.I.1967, 1 ♀, 24.I.1967; same data except 33°30'S, 70°55'W, 510 m, 1 ♀, 1 ♂, 14.II.1966, 1 ♀, 16.III.1966 (UCB, UCR); 1 ♀, Salta de Pilmaiquen, 27.I.1951, Ross & Michelbacher (CAS); 4 ♂♂, Santiago, X.1959, Santa Cruz leg., criado en laboratorio (UCC, USNM).

Discussion.--The wing pattern of nova (fig. 74) most closely resembles that of conversa (fig. 76). In both species the anterior apical band is interrupted at its junction with the subapical band by an anterior extension of the

hyaline area posterior to it, sometimes attaining the costa. If the anterior apical band is not completely interrupted, the hyaline area produces a semicircular incursion along the posterior margin of the band. In most specimens the posterior apical band (spot) is absent, although in a few specimens of nova it may be represented at most by a dark cloudiness, never by a spot with distinct margins. R. nova and conversa also share a distinctive type of ovipositor tip with minute lateral subapical projections (figs. 30, 31); this character is shared with willinki and penela but is different from the simple unadorned tip of lycopersella and tomatis.

R. nova is easily distinguished from conversa in having yellow genal setulae anterior and posterior to the genal bristle, yellow postocellars, and all four of the bars in the scutal pattern (fig. 14) distinctly united anterior to the transverse suture. The subbasal band of the wing pattern in nova is usually widest at crossvein r-m and narrowed anterior and posterior to it (fig. 74), whereas in conversa this band is parallel-sided without narrowing in all specimens examined (fig. 76) (see discussion of conversa).

An interesting variant of nova has been found in several specimens examined during this study in which the subapical band possesses a projection pointed toward the wing apex just below the anterior apical band at a point where the posterior apical band would originate if it were present (fig. 75). In most of these specimens the anterior apical band is completely interrupted at its base, and many of them have no, or very little, black on the forefemur and midfemur. However, I have not been able to correlate these characters with others or with distributional patterns well enough to be assured they represent a distinctive population. Additional study material may shed more light on this situation. The distribution of nova is given in map 1.

Biology and economic importance.--R. nova undoubtedly is one of the "strains" to which Olalquiaga-Fauré (Fauré, 1958) referred in his discussion of hosts "ochraspis" (see discussion of nova group). The females of nova, along with those of conversa, cannot be induced to oviposit in cultivated tomatoes. Except for the host information given in table 2, nothing is known about the biology of this species. The species from Angol collected by Bullock is not identical with Peruvian "ochraspis," as reported by Kisliuk and Cooley (1933, p. 239), but probably is conspecific with either lycopersella or tomatis.

Rhagoletis conversa (Brèthes)

(Figs. 15, 31, 76; map 1)

Spilographa conversa Brèthes 1919: 43; fig. 10 (wing). Type-locality, Río Blanco, Chile.
Rhagoletis conversa (Brèthes): Aczél 1954: 76, 77 (in key, neotropical species).--Foote 1967: 57.40 (in neotropical catalog).

Diagnosis.--Apex of third antennal segment distinctly pointed; postocellars black; thorax predominantly black; scutal pattern (fig. 15) consisting of 4 longitudinal bars completely separated from each other by black stripes, lateral bars visible along nearly entire length of scutum but appear to be

broken at transverse suture, black stripes between bars about subequal in width; scutellum yellow with transverse basal black border which also extends posteriorly along sides; 0.6 to all (avg. 0.9) of forefemur black, 0.5-0.8 (avg. 0.7) of midfemur black, 0.7-0.9 (avg. 0.9) of hindfemur black; foretibia and midtibia yellow, 0.7-0.9 (avg. 0.8) of hindtibia black; all transverse wing bands complete (fig. 76), discal band parallel-sided; anterior apical band narrowed at base or completely interrupted by hyaline area extending to costa, sometimes widely; posterior apical band completely absent, without sign of spot or clouding on vein M; accessory costal spot present; posterior margins of abdominal tergites with narrow transverse yellow bands.

Description.--In profile, head about 1.3 times as high as long, gena about 0.2 times as high as eye; only lower half of face visible in lateral view; antennal foveae deep, extending nearly to oral margin, relatively wide throughout entire length; frons yellowish brown, a little longer than wide; genal setulae black anterior to genal bristle, yellow posterior to it; all head bristles black except postocellars, which are yellow; antenna yellow, about half as long as face; third segment drawn to sharp point apically; most of basal expanded part of arista yellow; occiput yellow in most specimens, but irregular dark lines or patches may be present between rows of postoculars. Thorax predominantly black; yellow stripe between humerus and wing base relatively narrow, about 3.5 times as long as wide, upper anepisternal bristle in posteroventral corner; scutal pattern (fig. 15) consisting of 4 longitudinal bars completely separated from each other by black longitudinal stripes of approximately equal width, lateral light bars interrupted in region of transverse suture; scutal setulae yellow, separated from each other by approximately their own length; scutellum with black band at scutoscutellar suture which projects laterally on each side. Legs yellow with black markings as follows: 0.6-1.0 (avg. 0.9) of forefemur (table 1), 0.5-0.8 (avg. 0.7) of midfemur, 0.7-0.9 (avg. 0.9) of hindfemur, 0.7-0.9 (avg. 0.8) of hindtibia; 1-2 preapical anteroventral bristles on hindfemur. Wing (fig. 76) with 4 well-developed transverse bands, discal band parallel-sided, rarely as wide as length of stigma; anterior apical band always narrowed or interrupted at its point of junction with subapical band by rounded extension of hyaline area posterior to it; posterior apical band completely absent, without sign of spot or clouding on vein M; accessory costal spot present. Abdomen black, with narrow transverse yellow stripes on posterior margins of tergites II-V of male and also on tergite VI of female, each stripe somewhat wider at midline than laterally; ovipositor (fig. 31) with tip having minute pair of lateral projections, ratio of width to length 0.10-0.15, sides evenly rounded, internal projections ending at about basal 0.3; appendix of aedeagus about half again as long as main body, with distinct spinelike setulae; ejaculatory apodeme less than twice as long as wide; prensisetae situated at about distal 0.6-0.7 of surstylus.

Material examined.--CHILE: 1 ♀, W Canela Baja, Coquimbo, 23.X.1961, L. E. Peña (USNM); 3 ♀♀, Con-Con, Valparaiso, 15.VIII.1959, Santa Cruz, leg., ex larva (UCC, USNM); 1 ♀, Fundo La Montana, Estero La Palma at Rio Teno, 6 km E Los Quenos, Curico Prov., 4.I.1967, M. E. Irwin (USNM); 6 ♀♀, 2 ♂♂, Guardia Vieja, Aconcagua, 27.XII.1957, Santa Cruz, leg., s/Solanum tomatillo (UCS, USNM); 2 ♂♂, La Cruz, Valparaiso, 25.I.1964, S. Rojas, coll. (UCC); 2 ♂♂, Putaendo, Aconcagua, 30.XII.1958, Olalquiaga O-Fauré leg. (USNM); Quebrada de la Plata, nr. Maipú, 510 m., malaise, 33°30'S, 70°55'W, Santiago Prov., M.

E. Irwin, 2 ♀♀, 2.II.1966, 3 ♀♀, 8.II.1966, 2 ♀♀, 2 ♂♂, 14.II.1966, 1 ♀, 16.III.1966; same data except 33°31'S, 70°47'W, 2 ♀♀, 15-16.XI-1966, 1 ♂, 31.V.1966 (UCR, USNM); 1 ♀, Rio Blanco, Malleco Prov., 21.XII.1917, E. P. Reed, coll. (USNM); 1 ♀, San Esteban, Aconcagua, Campos de Ahumada, 22.XI.1962, G. O. F., leg. (USNM).

Discussion.--The wing pattern of conversa (fig. 76) most closely resembles that of nova in that the anterior apical band is narrowed or interrupted at its junction with the subapical band (see discussion of nova). The differences in wing patterns of these two species generally are not sufficient to distinguish them from each other except the subbasal band, which in conversa is distinctly parallel-sided from the stigma to its posterior termination, not at all widest at crossvein r-m and narrowed anterior to it, as in nova.

In conversa the genal setulae are black anterior to the genal bristle and yellow posterior to it, whereas in nova all the setulae are yellow. In conversa the postocellars are black, whereas in nova they are distinctly yellow. The most distinctive difference between the two species is the scutal patterns; in conversa (fig. 15) the four longitudinal bars are completely separated anterior to the transverse suture, whereas in nova all of them are united in that area (fig. 14) (see also table 3).

Unfortunately I have not had access to the type-specimen of conversa Brèthes. Although the illustration of the wing by Brèthes with his original description is inaccurate in several respects regarding wing venation, he shows the subbasal band of the pattern to be distinctly parallel-sided, a feature found exclusively in all the specimens studied. Moreover, my study material includes a specimen agreeing well with Brèthes' description. It was collected by E. P. Reed in 1917 from a locality indicated as "Río Blanco." Although I have found several localities labeled Río Blanco on various maps of Chile, evidence provided by O. S. Flint, Jr., Department of Entomology, National Museum of Natural History, Smithsonian Institution, points to the distinct possibility that the holotype of conversa was collected at or near the small town of Río Blanco ESE of Curacutín at the extreme southern border of the Province of Malleco in central Chile. I assume that this Río Blanco is the same as that from which the Reed female was taken.

Biology and economic importance.--Except for a minimum of host information (see table 2), the biology of this species is entirely unknown. Like nova, it very probably is incapable of infesting cultivated tomatoes (see discussion of nova and nova group). It is of much more limited distribution than nova (map 1).

Rhagoletis willinki Aczél

(Figs. 16, 32, 77; map 1)

Rhagoletis willinki Aczél 1950: 319; fig. 4, A-G (head, ovipositor); pl. 1, fig. C (wing). Type-locality, Villa Angostura, Neuquén, Argentina.--Aczél 1954: 77 (in key, neotropical species).--Foote 1967: 57.41 (in neotropical catalog).

Diagnosis.--Apex of third antennal segment distinctly pointed; postocellars black; thorax predominantly black; scutal pattern (fig. 16) consisting of 4 longitudinal bars, 2 on each side of midline distinctly united anterior to transverse suture but tending to disappear posterior to transverse suture; scutellum yellow with broad basal black border which extends posteriorly along sides, rendering scutellum more black than yellow; 0.8 to all (avg. 0.9) of forefemur black, 0.9 of midfemur black, nearly all of hindfemur black; foretibia yellow, middle half of midtibia and nearly all of hindtibia black; all transverse wing bands complete (fig. 77), relatively wide, subbasal and discal bands separated by hyaline area narrower than either of these bands; anterior apical band very wide, interrupted to costa by narrow hyaline fascia, extending well into apex of cell M, a distinct spot present on vein M representing posterior apical band; accessory costal spot present; posterior margins of abdominal tergites without narrow yellow bands, concolorous with remainder of tergite surfaces.

Description.--In profile, head about 1.3 times as high as long, gena about 0.2 times as high as eye; entire face visible in lateral view, margin nearly straight; antennal foveae deep, extending 0.6 of distance between antennal bases and oral margin; frons yellow, approximately square; frontal, genal, and gular setulae black; all head bristles black, including postocellars; antenna yellow, about 0.7 times as long as face; third segment with blunt point apically, apex not drawn out sharply; arista missing; occiput evenly and broadly dark to near postorbitals and ventrally to below occipital foramen. Thorax predominantly black; yellow stripe between humerus and wing base about 4.0 times as long as wide, wedge shaped, upper anepisternal bristle situated in extreme posteroventral corner; scutal pattern (fig. 16) consisting of 4 longitudinal bars, 2 on each side of midline distinctly united anterior to transverse suture but tending to disappear posterior to it; scutal setulae black, separated from each other by less than their own length; scutellum with broad black band at scutoscutellar suture which extends broadly posteriorly along sides, rendering scutellum more black than yellow. Legs yellow with black markings as follows: 0.8-1.0 (avg. 0.9) of forefemur, 0.9 of midfemur, more than 0.9 of hindfemur, middle 0.5 of midtibia, 0.9 of hindtibia; 2 preapical annteroventral setae on hindfemur. Wing (fig. 77) with 4 well-developed transverse bands, all relatively wide, subbasal and discal bands separated by hyaline area narrower than either of these bands; anterior apical band very wide, interrupted to costa by very narrow hyaline fascia, band extending well into apex of cell M; distinct spot on vein M representing posterior apical band; accessory costal spot present. Abdomen black, posterior margins of tergites II-V in male and VI in female not present, concolorous with remainder of tergite surfaces; ovipositor (fig. 32) only 1.05 mm long, ratio of width to length 0.19, tip with 2 minute subapical lateral projections, internal projections short, ending at about middle of ovipositor; aedeagus missing; ejaculatory apodeme about 2.0 times as long as wide; prensisetae situated at about apical 0.7 of surstylus; surstylus relatively wide in lateral view.

Material examined.--Holotype (female) and allotype (male), Villa Angostura, Neuquen, Argentina, 12.XI.1946, Hayward-Willink, Inst. Miguel Lillo Prep. No. 50 (IML).

Discussion.--R. willinki and penela form a rather distinctive subgroup of the nova group in that the wing patterns of both species (figs. 77, 78) consist of relatively wide bands. The subbasal and discal bands are separated by a hyaline fascia distinctly narrower than the dark discal band and the anterior apical band occupies the full width of cell R3 apicad of the subapical band. The posterior apical band is represented in both species by a distinct spot on vein M, and the subapical band has a projection that gives the impression of forming the base of the incomplete posterior apical band. Moreover, the abdominal tergites of both species are not margined with yellow transverse bands as in the other species of the nova group, and the ovipositors of both species (figs. 32, 33) are relatively short for their width.

The scutal pattern (fig. 16) of willinki is rather obscure in the type-specimens, especially posterior to the transverse suture, but enough is visible to show that the two lateral bands are united on each side. This condition is also true for penela. R. willinki may be distinguished from penela, at least in the type-specimens available for this study, by the anterior apical band, which is completely interrupted to the costa by a narrow hyaline band.

Biology.--R. willinki is an Argentine species (map 1). Nothing is known about its host relationships, although it would not be surprising to find that it, like the other species of the nova group, depends on the Solanaceae as a source of food.

Rhagoletis penela, new species

(Figs. 4, 17, 33, 78; map 1)

Diagnosis.--Apex of third antennal segment pointed; postocellars black; thorax predominantly black; scutal pattern (fig. 17) consisting of 4 longitudinal bars, 2 on each side of midline distinctly and broadly united anterior to transverse suture, black stripes separating them very narrow; scutellum yellow with transverse basal black border which also extends posteriorly along sides; 0.8 of forefemur and middle 0.7 of midfemur black; 0.5 of foretibia and 0.8 of midtibia black; hindlegs missing; wing (fig. 78) similar to that of willinki; all transverse wing bands present, subbasal band narrower than that of willinki, subbasal and discal bands separated by hyaline area narrower than either of these bands; anterior apical band very wide, not narrowed or broken at or near base; distinct spot on vein M representing posterior apical band; accessory costal spot present; posterior margins of abdominal tergites without narrow yellow bands, concolorous with remainder of tergite surfaces.

Description.--In profile, head about 1.25 times as high as long (fig. 4), gena about 0.2 times as high as eye; entire face visible in lateral view, central half slightly concave; antennal foveae deep, extending all the way from antennal bases to oral margin; frons yellow, approximately square; frontal, genal, and gular setulae black; all head bristles black, including postocellars; antenna yellow, about 0.8 times as long as face; third segment drawn out to very sharp point apically; expanded base of arista entirely dark brown to

black; occiput evenly and broadly dark dorsally to bases of verticals, laterally almost to postoculars, and ventrally well into gular region. Thorax predominantly black; yellow stripe between humerus and wing base about 3.5 times as long as wide, distinctly wedge shaped, upper anepisternal bristle situated in extreme posteroventral corner; scutal pattern (fig. 17) consisting of 4 longitudinal bars, 2 on each side of midline distinctly and broadly united anterior to transverse suture, black stripes separating them of equal width but very narrow; scutal setulae black, separated from each other by less than their own length; scutellum with very broad black band at scutoscutellar suture which extends broadly posteriorly along sides, rendering scutellum more black than yellow. Legs with black as follows: 0.9 of forefemur, 0.9 of midfemur, middle 0.5 of foretibia, middle 0.8 of midtibia, hindlegs missing. Wing (fig. 78) with 4 well-developed transverse bands, subbasal band narrowest of all, discal band rather wide and separated from subbasal by hyaline area narrower than discal band; anterior apical band very wide, not narrowed or broken at or near base; distinct spot on vein M representing posterior apical band; accessory costal spot present. Abdomen black, posterior bands on margins of tergites II-IV in male and II-VI in female narrowly present, concolorous with remainder of tergite surfaces; ovipositor (fig. 33) 1.0 mm long, ratio of width to length 0.23, tip with minute subapical lateral projections, sides rounded; spermatheca as in figure 47.

Holotype.--Female, Pichinahuel, Arauco, Chile, 23-31.XII.1958, L. E. Peña, collector (CNC).

Discussion.--R. penela shares several characters with willinki to set these two species apart as a rather distinctive subgroup of the nova group (see table 3 and the discussion of willinki). R. penela is rather easily distinguished from willinki by the absence in its wing pattern of any break or interruption in the anterior apical band; in willinki a narrow hyaline fascia is present entirely through the band (figs. 77-78).

Biology.--R. penela is a Chilean species (map 1). Nothing is known of its host relationships, although it is likely to be found associated with the Solanaceae, as are some other members of the nova group.

Etymology.--The name penela is an anagram of the name L. E. Peña, whose collecting has resulted in the discovery of this new species.

RHAGOLETIS PSALIDA GROUP

Diagnosis.--Thorax and abdomen black with yellow markings; postocellars black; scutum without integumental pattern, setulae forming pattern in 1 species; scutellum completely black; legs yellow, femora with extensive black markings; wing pattern with 3 separate transverse bands; anterior apical band complete but may be broken at base; posterior apical band narrowed to incomplete or represented only by a spot; accessory costal bar present; abdominal tergites with yellow transverse marginal fasciae in 2 of the 3 species; apical process of glans haired, tunica bare; spermatheca rodlike. (Table 4.)

Discussion.--Most of our knowledge about psalida and the dark species related to it is recorded in Hendel's work on South American Tephritidae (Hendel,

TABLE 4.--Differentiating morphological characters of species in psalida group

Character	psalida	rhytida	metallica
Head color	Dark yellow	Light yellow	Light yellow.
Genal spot	Present	Absent	Absent.
Distribution of genal setulae.	In pattern	Not patterned	Not patterned.
Dorsal surface of scutellum.	Convex, smooth	Flat, wrinkled	Flat, wrinkled.
Transverse abdominal bands.	Wide, white pollinose.	Narrow, yellowish white.	Absent.
Anterior apical band.	Complete	Incomplete or narrow.	Incomplete.
Posterior apical band.	Elongate	Rounded spot	Rounded spot.

1914). I have no doubt that psalida and rhytida belong to a species group equivalent to the others as treated in this study, but my assignment of metallica to it is highly tentative and is made solely on the basis of Hendel's somewhat incomplete overall description of a Venezuelan specimen and Hardy's wing description (Hardy, 1968). No specimens of Rhagoletis from Venezuela were available for this study.

On the assumption that metallica is a high-altitude species like psalida and rhytida and that it is closely enough related morphologically to these species to be included in the psalida group, it is of considerable interest to note that the group as a whole is confined to high altitudes in western South America (map 2). It very proably has become isolated geographically from the nova group, which it closely resembles.

Rhagoletis psalida Hendel

(Figs. 5, 18, 26, 34, 48, 56, 62, 67, 79, 80; map 2)

Rhagoletis psalida Hendel 1914: 29 (in key, neotropical species; in neotropical catalog); 30 (description). Type-localities, Cuzco and Urubamba, Peru.--Hering 1941: 142 (in key, Peruvian species; description).--Aczél 1949: 240 (in neotropical catalog).--Aczél 1954: 76 (in key, neotropical species).--Foote 1967: 57.41 (in neotropical catalog).

Diagnosis.--Frons parallel-sided, as wide as eye, longer than wide, darker yellow anteriorly than posteriorly; face yellowish white, straight or convex in lateral view; third antennal segment pointed apically; gena wide, an indistinctly bordered dark spot directly below eye; occiput without brownish markings; scutum (fig. 18) completely black, without integumental markings but with golden to yellowish-white setulae forming pattern as shown; scutellum shining

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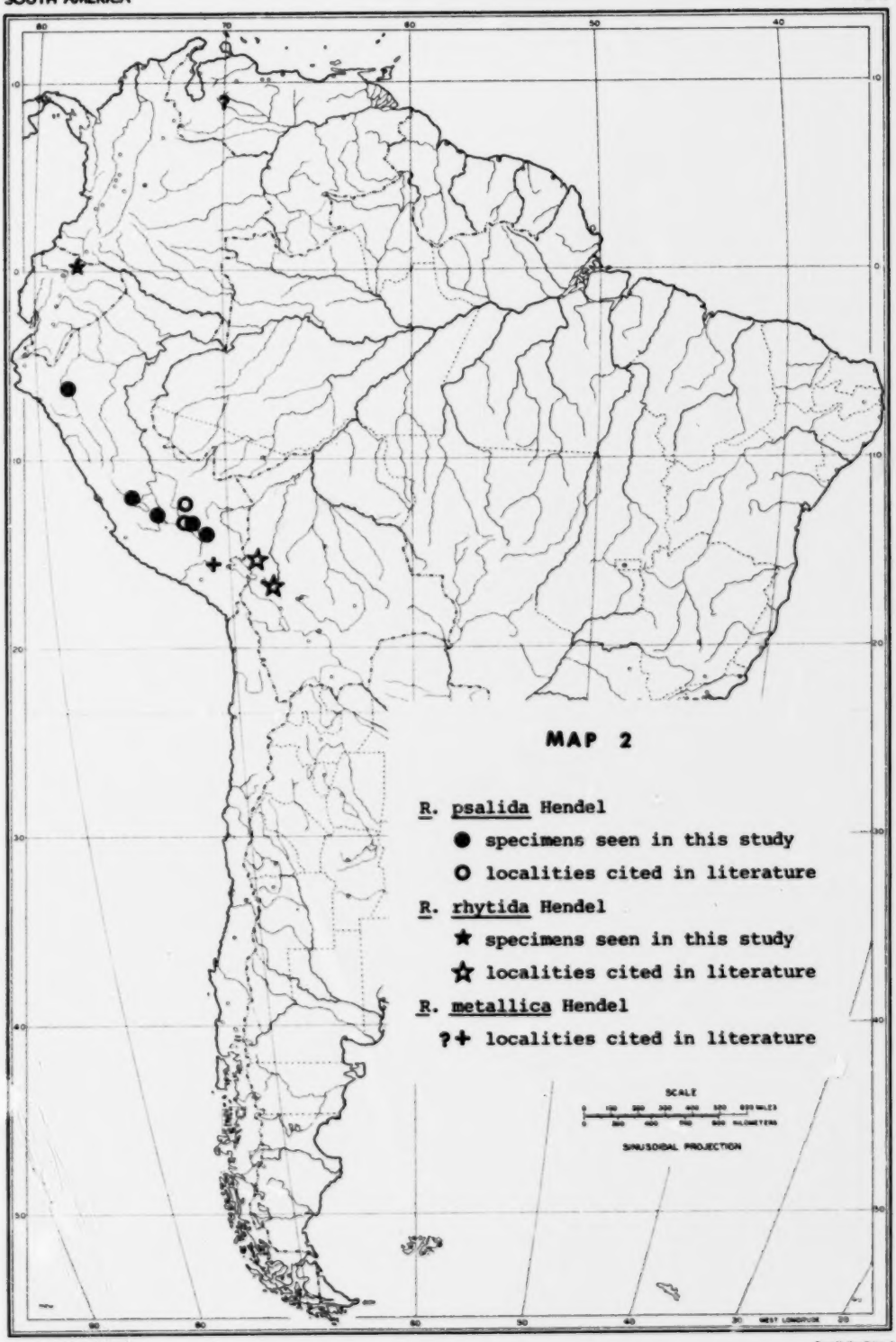

GOODE BASE MAP SERIES

black, with evenly convex dorsal surface; femora almost entirely black except at extreme apices; hindtibia broadly dark at middle, remainder of legs yellow; all transverse wing bands present (figs. 79, 80); anterior apical band complete, united to preapical band without appreciable narrowing; cell R3 at junction of 2 bands almost entirely dark; posterior apical band relatively elongate, usually attaining wing margin but often not connected to preapical band; tergites II-IV in male and II-V in female with wide transverse yellow-to-white marginal bands.

Description.--Head dark yellow; in profile (fig. 5) about 1.3 times as high as long, posteroventral margin of eye straight, not rounded; gena about 0.3 times as high as eye, with indistinctly margined dark area directly below eye; genal setulae almost as long as genal bristle in vicinity of bristle, becoming shorter anteriorly, all black anterior to bristle, yellow posterior to it; face easily visible in profile, anterior margin nearly straight; antennal fossae deep, extending to oral margin; facial carina flattened along most of its length; antenna dark yellow, about 0.6 times as long as face, third segment drawn to minute but sharp point, or at least distinctly right-angled at anteroapical corner; entire thickened base of arista yellow; all head bristles black, including postocellars; ocellars and postocellars rather long; frons very dark yellow, with almost brownish area in anterior third, about as long as wide at ocellar triangle, setulae short, black, sparse. Thorax black; humerus black, with narrow, triangular yellow band from humerus to wing base, upper anepisternal bristle situated in black area; scutum (fig. 18) without integumental pattern of longitudinal bars, but with golden to yellowish-white setulae, each much longer than distance between them, forming distinct pattern with posteriormost setulae overlying lateral basal corners of scutellum; dorsal surface of scutellum evenly convex, surface smooth, setulae colorless and located on lateral surfaces only; postscutellum and metanotum black. Legs with forefemur 0.9 black, more extensively darkened on dorsal than on ventral surface; midfemur and hindfemur almost entirely black, yellow at extreme apices; foretibia and midtibia yellow; hindtibia black on central 0.9, yellow at base and apex; tarsomeres IV and V darker than I-III; ventral bristles of forefemur delicate, longest at middle of row; 1 subapical anteroventral bristle on hindfemur. Wing pattern (figs. 79, 80) with all transverse bands present, relatively wide; first costal cell as dark as subbasal band; anterior apical band not or very little narrowed at its junction with preapical band, cell R3 dark for at least half its width at this point; posterior apical band represented by elongated spot, sometimes completely but narrowly united with preapical band, often not attaining posterior wing margin; accessory bar present. Abdomen mostly shining black; tergites II-IV in male and II-V in female each with whitish pollinose transverse marginal bands much wider at centerline than laterally, bands on tergites II and III each about 0.5 times as wide as tergite, band on tergite IV of male and IV and V of female about 0.2 to 0.25 as wide as tergite; tergite V of male and VI of female each with narrow dark-brown posterior borders; ovipositor sheath slightly longer than tergite VI; ovipositor (fig. 34) 1.3-1.5 mm long, tip drawn to narrow point, internal rays meeting as shown; glans of aedeagus (fig. 56) drawn to rather slender point with spicules at extreme apex, rather heavily spined apically; prensisetae (fig. 67) located at apical third of surstylus, apex of surstylus rather broadly triangular.

Material examined.--PERU: 1 ♀, 4 mi E. Acobambo, Junin, 31.XII.1954, E. I. Schlinger & E. S. Ross; 4 ♀♀, 1 ♂, Cajamarca, 1970, G. Vilchez, on potato leaves; 3 ♀♀, 3 ♂♂, Cuzco, 6.IV.1962, I. Ceballos B.; 1 ♀, 1 ♂, Cuzco, 1962, "ex potato," M. Saavedra; 1 ♀, 1 ♂, Cuzco, VII.1962; 1 ♂, Cuzco, 3.IV.1963, Maras; 1 ♀, 3 ♂♂, Huancayo, 16.III.1946, J. Lamas; 1 ♀, Sicuani, 3000 m, 1.III.1951, Ross & Michelbacher. (All USNM.)

Discussion.--R. psalida is a very distinctive species with characters that allow it to be separated easily from all other known American members of the genus. The most prominent of these is the distribution of the golden or yellowish-white scutal setulae in a distinct pattern (fig. 18) and the posterolateral setulae forming weak tufts that overlap the base of the scutellum at each end of the scutoscutellar suture. The scutum is without an integumental pattern of longitudinal bars; the dorsal surface of the scutellum is evenly convex and entirely black; and the transverse fasciae on at least tergites II and III of both male and female are whitish pollinose, about half as wide at the centerline as their respective tergites and narrowed conspicuously at the lateral margins of the abdomen. Additionally, the anterior apical band of the wing pattern is not conspicuously narrowed at its junction with the preapical band, and the head and parts of the body and legs are dark yellow rather than the bright yellow usually seen in members of the nova group and of rhytida.

A small series of specimens from Tiraque, Bolivia, near La Paz at the southern end of the distribution of psalida have all the general characteristics of that species but have wings with a pattern closely resembling that shown by Hardy (1968, fig. 4) for metallica, with a slightly elongated but distinctly rounded dark spot at the apex of vein R2+3 (fig. 80). According to Hendel's description, however, they cannot be metallica, but the wing pattern leads one to speculate they may represent an undescribed species very similar to psalida. They were collected on February 14, 1976, at 3,500 meters "ex potato fruits." These specimens are only mentioned as they are in very poor condition and not usable for further description.

Biology and economic importance.--The larvae of psalida were reported by Munro (1968) as very common in potato fruits near Lake Titicaca, but between 1951 and 1955 they did not appear to be of any economic importance in that area.

Rhagoletis rhytida Hendel

(Figs. 6, 35, 49, 81; map 2)

Rhagoletis rhytida Hendel 1914: 29 (in key, neotropical species; in neotropical catalog); 30 (description). Type-localities, La Paz and Yungasweg, Bolivia.--Aczél 1949: 240 (in neotropical catalog).--Aczél 1954: 76 (in key, neotropical species).--Foote 1967: 57.41 (in neotropical catalog).

Diagnosis.--Frons parallel-sided, as wide as eye, longer than wide; face yellowish white, straight or slightly convex in lateral view (fig. 6); third

antennal segment drawn to sharp point apically; gena yellow, concolorous with remainder of head; occiput without brown markings; scutum completely black, without integumental pattern, golden to yellowish setulae evenly distributed and not forming a pattern; scutellum convex apically, flat on basal half, with longitudinal wrinkles in integument, shining; femora almost entirely black except at extreme apices; hindtibia broadly dark at middle, remainder of legs yellow; all transverse bands of wing pattern present (fig. 81); anterior apical band incompletely or not at all connected to preapical band; cell R3 almost or entirely hyaline at junction of preapical and anterior apical bands; posterior apical band represented by only apical spot at center of apical sector of vein M; tergites II-IV in male and II-V in female with narrow marginal yellow to yellowish-white transverse bands.

Description.--Head light yellow; in profile (fig. 6) about 1.3 times as high as long, posteroventral margin of eye normally rounded; gena about 0.25 times as high as eye, only very indistinctly darkened, if at all, below eye; genal setulae rather long in vicinity of genal bristle, becoming shorter anteriorly, all black anterior to bristle, yellow to posterior to it; face easily visible in profile, anterior margin slightly bowed anteriorly at middle; antennal fossae deep, not extending entirely to oral margin; facial carina flattened along most of its length; antenna bright yellow, about 0.7 times as long as face, third segment drawn to distinct, prominent sharp point; entire thickened base of arista yellow; all head bristles black, including postocellars; ocellars and postocellars rather long; frons yellow, unicolorous and concolorous with remainder of head, about as long as wide at ocellar triangle, setulae long, black, prominent. Thorax black; humerus black, with narrow, whitish triangle extending from humerus to wing base, anepisternal bristle situated in posteroventral corner; scutum without integumental pattern of longitudinal bars; yellow setulae evenly distributed on surface, closer together than their own length, largely absent behind acrostichals; at least basal half of scutellum flat, with longitudinal wrinkles, surface shining; long, colorless setulae sparsely distributed over most of surface; postscutellum and metanotum black. Legs with all coxae and femora mostly black, extreme apices yellow; foretibia and midtibia yellow; hindtibia black on central 0.9, yellow at base and apex; tarsomeres unicolorous; ventral bristles of forefemur delicate, longest near middle of row; hindfemur with 2-3 outstanding subapical anteroventral bristles. Wing pattern (fig. 81) with all transverse bands present, relatively narrow; first costal cell yellowish, lighter in color than subbasal band; anterior apical band distinctly narrowed or broken at its junction with preapical band; cell R3 mostly or entirely hyaline at this point; posterior apical band represented only by distinctly bordered spot on vein AM; accessory bar present. Abdomen mostly shining black; tergites II-IV in male and II-V in female each with narrow yellowish-white transverse marginal bands, somewhat wider at centerline than laterally, bands on tergites II and III each not more than 0.25 as wide as tergite, becoming progressively narrower posteriorly; posterior margins of tergite V in male and VI in female entirely black; ovipositor (fig. 35) about 0.8 mm long, drawn to distinct sharp point at tip, internal rays meeting as shown; spermatheca as in figure 49.

Material examined.--1 ♀, Yaguarcocha, 3 km N. Ibarra, Imbabura, Ecuador, 1950 m, 8-9.VI.965, L. Peña (CNC).

Discussion.--Hendel's original description of rhytida leaves little doubt

that the single specimen seen in this study is conspecific. Although I have not seen Hendel's type-specimen, the female in my collection agrees in every particular with the specimens discussed by him. Among all other American species of Rhagoletis, especially psalida, rhytida may be recognized easily by its flattened, wrinkled, entirely black scutellum and by its wing pattern, in which the anterior apical bar is markedly narrowed at its junction with the preapical band or is completely separated from it as in figure 81. The bright yellow of this species contrasts markedly with the shiny black parts of its body and legs and in this respect is rather different from psalida, in which the yellow parts for the most part are much darker. Because the single specimen of rhytida seen in this study is from a locality far from the type-locality of the species (map 2), one must assume that it will eventually be found sympatric with psalida.

Biology.--No information is available on the biology of this species.

Rhagoletis metallica Hendel

(Map 2)

Spilographa metallica Schiner 1868: 265. Type-locality, Venezuela (per Hardy, 1968).

Rhagoletis metallica (Schiner): Hendel 1914: 29 (in key, neotropical species; in neotropical catalog; description).--Hering 1941: 142 (in key, Peruvian species; description).--Aczél 1949: 239 (in neotropical catalog).--Aczél 1954: 79 (in key, neotropical species).--Foote 1967: 57.41 (in neotropical catalog).--Hardy 1968: 134 (redescription of type-specimen); fig. 4 (wing pattern).

Diagnosis.--Frons parallel-sided, as wide as eye, longer than wide, yellow throughout; face yellowish white, straight or convex in lateral view; gena yellow, concolorous with remainder of head; occiput yellow with brown markings laterally at level of occipital foramen; third antennal segment drawn to sharp point apically; scutum completely black, without integumental pattern, setulae yellowish and evenly distributed; scutellum completely black, flattened, finely punctate; femora almost entirely black except at extreme apices; hindtibiae broadly dark at middle, remainder of legs yellow; all transverse wing bands present and complete; anterior apical band not connected to preapical band, represented by only isolated dark spot at apex of vein R4+5; cell R3 entirely hyaline immediately distad of preapical band; posterior apical band represented by only a diagonally placed spot in center of apical sector of vein M; abdominal tergum entirely black, without transverse bands at posterior margins of tergites; ovipositor sheath very short, shorter than tergite VI, black basally, reddish apically.

Discussion.--The diagnosis accompanying this discussion is drawn entirely from Hendel's original description (1914), from Hering(1941), and from Hardy's description of the wing pattern (1968, fig. 4). No specimens of Rhagoletis recognizable as metallica were seen in this study. Presumably metallica can be recognized by the wing pattern illustrated by Hardy and by the flat, smooth, finely punctate scutellum, a character emphasized by Hendel. The specimens from Tiraque, Bolivia, mentioned in my discussion of psalida, are most probably

not metallica despite the similarity in wing pattern, because they too closely resemble psalida in the pattern of the scutal setulae, the presence of wide, light-colored transverse abdominal fasciae, the convex scutellum, and the structure of the ovipositor.

One might well assume that the type-locality of metallica is high in the western mountains of Venezuela (map 2), although no specific information is available on this point.

Biology.--No information is available on the biology of this species.

RHAGOLETIS STRIATELLA GROUP

Diagnosis.--Thorax and abdomen black with yellow markings; postocellars black or yellow; scutum with 2 to 4 longitudinal bands in integumental pattern; scutellum with black base and sides; legs yellow with extensive black markings on femora; wing pattern with 3 separate transverse bands; anterior and posterior apical bands complete and unbroken; accessory costal bar absent; abdominal tergites with transverse yellow to whitish marginal fasciae; apical process of glans elongate, bare, tunica bare; spermathecae spherical.

Discussion.--The present association of jamaicensis and macquartii with striatella in a "species group" is highly tentative, primarily because (1) no males of either jamaicensis or macquartii were seen during this study and (2) the host relationships of these two species are completely unknown. I have based the association principally on the absence of an accessory costal spot in the wing pattern, on the intersecting of anterior extension of vein dm-cu with the center of that part of cell R1 that lies between the apex of the subcostal cell and the apex of the wing, on the uneven darkening of the hind-tibiae, and on the spherical spermathecae. R. jamaicensis and macquartii resemble each other closely in many respects despite the great physical distance separating their respective type-localities (see map 3). Table 5 gives the impression that the females of both may have a closer relationship to each other than to those of striatella. The eventual discovery of males and of hosts of these two species is required to determine the true relationships involved within and outside this group.

Rhagoletis striatella Wulp

(Figs. 19, 27, 36, 50, 82; map 3)

Rhagoletis striatella Wulp 1899: 408; pl. 11, fig. 30 (wing). Type-locality, Amula, Guerrero, Mexico.--Bezzi 1910: 15 (in key, American species); 19 (noted from Mexico).--Hendel 1914: 29 (in key, neotropical species; in neotropical catalog).--Cresson 1929: 405; pl. XVI, fig. 3 (wing).--Aczél 1949: 240 (in neotropical catalog).--Aczél 1954: 78 (in key, neotropical species).--Foote 1965: 239 (description of holotype).--Bush 1966: 454 (in key, nearctic species); 514 (description); figs. 41 (head); 42 (scutum); 89, 105, 134, 140 (male genitalia); 170 (spermatheca); 184 (ovipositor); 209 (wing); 234, 235 (chromosomes); 240 (micropyle of egg).--Foote 1967: 57.41 (in neotropical catalog).--Wasbauer 1972: 65, 132 (hosts).

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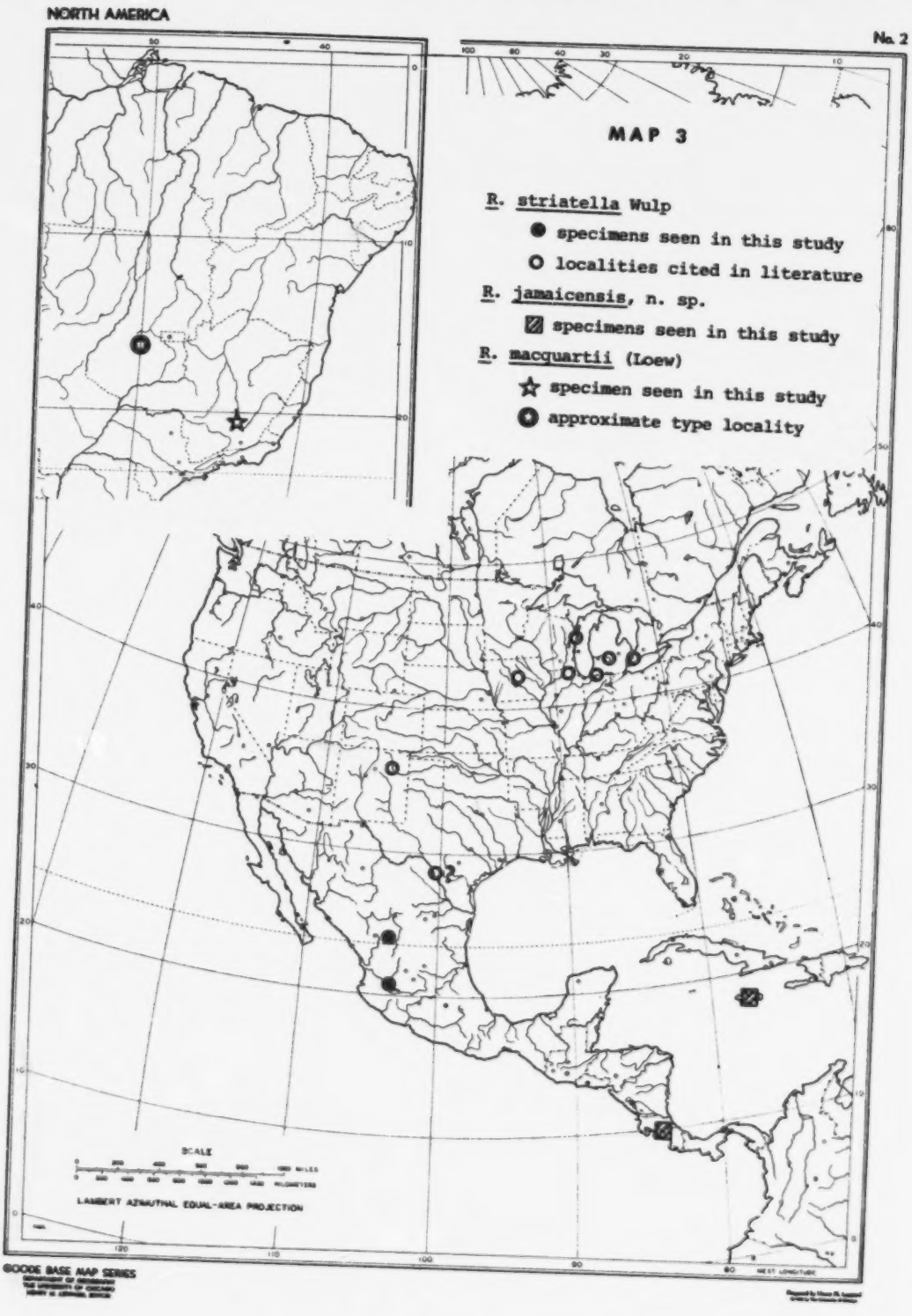

TABLE 5.--Differentiating morphological characters of species in striatella group

Character	striatella	macquartii	jamaicensis
Length of antenna (approx.).	0.5 times as long as face.	0.9 times as long as face.	0.7 times as long as face.
Color of postocellars.	Black	Yellow	Yellow.
Length/width of frons.	1.3	1.4	1.9
Bars in scutal pattern.	2	4	4
Uniting of scutal bars.	None	None	2 on each side.
Subbasal and discal bands of wing.	Not united	United	Not united.
Length and shape of ovipositor.	2.5-2.8 mm, bulbous.	Ca. 0.9 mm, straight sided.	Ca. 1 mm, straight sided.
Papillae of spermatheca.	Absent	Basal only	Basal only.

Diagnosis.--Frons about 1.3 times as long as width at ocellar triangle, setulae light brown; postocellars black; face with carina flattened; antenna about 0.5 times as long as face; third segment right-angled at anteroapical corner; scutal pattern (fig. 19) with 2 longitudinal bars set at slight angle to each other, making dark median line distinctly wider posteriorly than anteriorly, each bar divided longitudinally in middle by faint, very narrow dark fascia; about basal 0.8 of forefemur and nearly all of midfemur and hindfemur dark; hindtibia darkened, especially so in subbasal third and subapical half of segment; all transverse bands in wing pattern (fig. 82) complete, unbroken, discal and preapical bands often joined at posterior margin of wing; hyaline fascia between discal and preapical band narrower than latter; both apical bands complete; accessory costal spot absent; abdominal tergites dark with narrow transverse yellowish-white bands on posterior margins; bands on tergites II-IV of male and II-V of female about one-third width of tergite; tergite VI of female with brown posterior margin; ovipositor long, bulbous (fig. 36); spermatheca spherical (fig. 50); male terminalia as shown in Bush (1966; figs. 89, 105, 134, 140).

Description.--The species has been described in detail by Bush (1966). No characters additional to those given in the diagnosis and discussion accompanying this account are required to distinguish striatella from the other species in this distinctive group.

Material examined.--MEXICO: 1 ♀, Guadalahara, Jalisco, 15 mi. NE, 17.IX. 1970, G. E., R. M. Bohart (USL); 3 ♀♀, 2 ♂♂, 26 mi E Navios, El Salto, Durango, 2.VIII.1964, 8000', J. F. McAlpine (CNC, USNM); 1 ♀, husk tomato, 29.IX.1943, Eagle Pass No. 8033, USDA Lot No. 14-1886 (USNM).

Discussion.--In the past, striatella has been recognized as distinctive among American members of Rhagoletis as the only black-bodied species with a full complement of transverse and apical bands in the wing pattern in the absence of an accessory costal spot. With the discovery of jamaicensis and the rediscovery of macquartii, however, it becomes necessary to distinguish among these three species. In contrast to the other two species of the group, the scutal pattern of striatella has only two longitudinal bars, each divided longitudinally by a faint dark fascia; the postocellars are black; the forefemur is almost completely black; the transverse abdominal fasciae are much broader and lighter in color; and the ovipositor is very long and bulbous near its apex. See table 5 for a summary of characters separating all the members of this group.

Bush (1966, p. 444) speculated that striatella originated in Mexico, and that because of its head shape, setation, certain characteristics of the male genitalia, the slightly similar chromosomes, and its host, it closely resembles species of the genus Zonosemata Benjamin and may be related genetically to them.

Biology and economic importance.--R. striatella is a pest of considerable economic importance in Mexico, where it infests commercial plantings of the husk-tomato (Physalis spp.), which is used extensively for the preparation of sauces. No information on its biology is available. It is a high-altitude species in Mexico (map 3) but apparently does not occur south of there.

Rhagoletis macquartii (Loew)

(Figs. 7, 20, 37, 51, 83; map 3)

Urophora scutellaris Macquart 1851: 261 (separate, p. 288); pl. 26, fig. 15 (wing) (preocc. Wiedemann 1830). Type-locality, Goiás, Brazil.
Trypeta macquartii Loew 1873: 267 (new name for scutellaris Macquart).
Rhagoletis macquartii (Loew): Bezzi 1910: 15 (in key, American species); 18 (taxonomic discussion).--Foote 1967: 57.40 (in neotropical catalog).
Rhagoletis scutellaris (Macquart): Hendel 1914: 29 (in key, neotropical species; in neotropical catalog).--Aczél 1949: 240 (in neotropical catalog). --Aczél 1954: 77 (in key, neotropical species).

Diagnosis.--Frons narrow, setulae yellow; face with moderately sharp carina; antenna almost as long as face, third segment more or less angled at anteroapical corner; postocellars yellow; scutal pattern (fig. 20) with 4 longitudinal bars, none of them united anterior to transverse suture, lateral bars with broken appearance at suture, black lines between bars about equal in width; forelegs and midtibia entirely yellow, midfemur and hindfemur almost entirely black; hindtibia darkened subbasally and subapically; all transverse wing bands present, complete (fig. 83), subbasal and discal bands united along most of their lengths; anterior and posterior apical bands present, complete,

former with short, narrow hyaline areas at apices of veins R2+3 and R4+5; accessory costal spot absent; abdominal tergites dark, with narrow yellowish-white transverse bands on posterior margins.

Description.—In profile, head (fig. 7) about 1.3 times as high as long, posteroventral margin of eye straight, not rounded; gena about 0.2 times as high as eye, with moderately dark cloud directly below eye; some of genal setulae anterior to genal bristle black, all setulae posterior to bristle yellow; face easily visible in profile, anterior margin nearly straight; antennal fossae deep, extending to oral margin, facial carina rounded, at least as wide as either fossa; antenna yellow, about 0.9 times as long as face, third segment more or less right-angled at anteroapical corner but not distinctly rounded or drawn out to sharp point; entire thickened base of arista yellow; all head bristles black except postocellar, which is distinctly yellow; frons dark yellow, about 1.4 times as long as width at ocellar triangle, setulae yellowish brown and contrasting but little with surface color of frons. Thorax essentially black; median half of humerus yellowish brown, ectal half yellowish white and concolorous with whitish band extending to wing base, upper anepisternal bristle not included in whitish area; scutal pattern (fig. 20) consisting of 4 longitudinal bands, none of which are connected anterior to transverse suture, lateral bands appearing broken at suture, inner bands rather short posteriorly, hardly exceeding dorsocentrals, dark fasciae between them of equal width; basal 0.3 of scutellum evenly black, black extending posteriorly along sides, anterior scutellar bristles inserted in black area; halter yellowish white; postscutellum and metanotum entirely black. Legs yellow, with dark markings as follows: Forefemur with slight clouding just distad of middle of posterior surface, midfemur and hindfemur except extreme apices; hindtibia in apical and proximal thirds, middle third a lighter shade of brown; ventral setae of forefemur rather delicate, longest near middle of row; 1 moderately long subapical anteroventral bristle on hindfemur. Wing pattern (fig. 83) with all transverse bands present, subbasal and discal bands contiguous along most of their lengths, 2 bands together forming large, dark subbasal spot on wing disk; discal and preapical bands touching on hindwing margin; anterior and posterior apical bands present and complete, former with narrow costal hyaline areas at apices of veins R2+3 and R4+5 that tend to be confluent; accessory bar absent. Abdomen with tergum essentially black; posterior margins of tergites II-V of female each with very narrow yellowish-white transverse band about 0.15 times as wide as tergite; tergite VI entirely dark except very small yellowish area centrally on posterior margin; ovipositor (fig. 37) about 0.9 mm long, slightly expanded in outline at apical third, apex rather bluntly rounded, internal rays meeting as shown; spermatheca (fig. 51) spherical, with several papillae clustered at base.

Material examined.--BRAZIL: 1 ♀, Ouro Prêto, Minas Gerais, IV.1954, N. L. H. Krauss (USNM).

Discussion.--This species and jamaicensis are distinctive among American Rhagoletis in having yellow postocellars in combination with both apical bands in the wing pattern present and unbroken and the accessory costal spot absent (fig. 83). In these respects, both species are similar to striatella except for the black postocellars in the latter species. As shown earlier, all three species have spherical spermathecae, but macquartii and jamaicensis may be distinguished easily from striatella by the details of the wing banding and

scutal pattern (figs. 19-21). R. macquartii and jamaicensis are similar to each other in many respects, principally in the shape of the head (figs. 7, 8), the narrow frons with yellow rather than black setulae, the coloration of the legs and abdominal tergites, the nature of the basal papillae of the spermathecae (figs. 51, 52), and the shape and length of their ovipositors (figs. 37, 38). In the former species, however, the scutal pattern (fig. 20) shows the two bars on each side of the midline completely separated anterior to the transverse suture, whereas in jamaicensis the two bars are distinctly united anterior to the suture. Additionally, the subbasal and discal transverse bands of the wing pattern of macquartii are practically contiguous (fig. 83), whereas in jamaicensis they are almost completely separated. The very long antenna of macquartii is another useful distinguishing character.

Macquart's original description of this species is accompanied by the illustration of a wing pattern suggestive of that of the specimen before me. Although it is inaccurately drawn in showing the confluence of the subbasal and discal bands to be located farther apicad than in my specimen, no other neotropical Rhagoletis has this general kind of pattern, in which such a large dark spot occurs in the basal half of the wing disk.

Biology.--Nothing is known about the biology or host relationships of this species.

Rhagoletis jamaicensis, new species

(Figs. 8, 21, 38, 52, 84; map 3)

Diagnosis.--Frons narrow, setulae yellow; face with rather sharp carina; antenna about 0.7 times as long as face, apex of third segment distinctly rounded; postocellars yellow; thorax predominantly black; scutal pattern (fig. 21) with 4 longitudinal bars, 2 on each side united anterior to transverse suture; black fasciae between them about equal in width; forelegs and midtibia entirely yellow; midfemur and hindfemur almost entirely black; hindtibia blackened subapically and sometimes subbasally; all transverse wing bands complete and wide (fig. 84); hyaline fascia between subbasal, discal, and preapical bands narrower than any of these bands; both apical bands complete; accessory costal spot absent; abdominal tergites black with narrow yellowish-white transverse bands on posterior margins.

Description.--In profile, head about 1.4 times as high as long (fig. 8), posteroventral margin of eye straight; gena about 0.2 times as high as eye, distinctly darkened in small spot directly below eye, setulae black anterior to genal bristle, yellow posterior to it; face easily visible in profile, nearly straight; antennal fossae deep, extending to oral margin, facial carina sharp, narrower than either fossa, especially between third segments; antenna yellow, about 0.7 times as long as face, third segment distinctly rounded apically with but only slight suggestion of point subapically on dorsal surface; entire enlarged base of arista yellow; all head bristles black except postocellars, which are rather long and distinctly yellow; frons dark yellow, about 1.9 times as long as width at ocellar triangle, setulae yellow and not at all contrasting with yellow of frons. Thorax essentially black; medial half of humerus yellow, ectal half white and contiguous with parallel-

sided white band to base of wing, upper anepisternal bristle situated well within posteroventral corner of band; scutal pattern (fig. 21) consisting of 4 longitudinal bars, 2 on each side of midline connected to each other widely anterior to transverse suture, dark fasciae between bands rather wide and of equal width; basal half of scutellum black, with black extending posteriorly and broadly laterally; anterior scutellar bristles inserted well within black area; halter white; postscutellum and metanotum entirely black. Legs yellow, with black markings as follows: Nearly all of midfemur and hindfemur (only extreme apices of both yellow); basal and apical 0.15-0.33 of hindtibia (leaving central part light brown to yellow); ventral setae of forefemur longest and strongest at middle of setal row; 1 long subapical anteroventral seta on hindfemur. Wing pattern (fig. 84) with all transverse bands present, subbasal band wide and occupying most of cell BM; discal and preapical bands wide, separated from each other and from subbasal band by hyaline fasciae narrower than any of these bands; anterior and posterior apical bands present and complete, former with small but distinct hyaline spot at extreme apex of vein R2+3 and less distinct one at apex of vein R4+5; accessory bar absent. Abdomen with tergum essentially black, posterior margins of tergites II-V of female each with narrow yellowish-white transverse band about 0.2 times as wide as tergite; tergite VI not or only very faintly margined at extreme posterior border, only about half as wide as tergite V; ovipositor sheath black on basal 0.66, becoming very dark brown apically, about as long dorsally as tergites V and VI together; ovipositor (fig. 38) about 1.0 mm long, slightly expanded in outline in apical third, apex rather bluntly rounded, internal wings meeting as shown; spermatheca (fig. 52) spherical, with numerous prominent papillae clustered at base.

Holotype.--Female, Hardwar Gap, 4000', Jamaica, 25.VII.1966, Howden & Becker (CNC).

Paratypes.--1 ♀, same data as holotype (USNM); 1 ♀, Prov. San José, Costa Rica, 7.VII.1978, L. F. Jirón (USNM).

Discussion.--This species and macquartii are very distinctive species of American Rhagoletis in having wide, dark, clearly margined bands in the wing patterns as shown in figures 83 and 84. It is the only type of pattern other than that of striatella known to me with both anterior and posterior apical bands present and unbroken and in which the accessory costal spot is missing. These two species also resemble striatella in having spherical spermathecae. However, together they differ from that species in several respects (see table 5 and discussion of striatella).

Similarities of jamaicensis and macquartii are discussed under the latter species. In spite of these similarities, the latter species may be distinguished from the former in having the two bars on each side of the midline of the scutum distinctly united anterior to the transverse suture, the antenna is distinctly shorter than the face and the third segment is rounded apically, and the subbasal and discal bands of the wing pattern are separated by a nearly complete hyaline fascia. See the discussion of macquartii for these differences. The paratype from Costa Rica is the only specimen of Rhagoletis from Central America seen in this study.

Biology.--No information is available on the biology or host relationships of this species.

Etymology.--The specific epithet is a neo-Latin adjective formed from the locality name Jamaica.

RHAGOLETIS FERRUGINEA GROUP

Diagnosis.--Large species; thorax and abdomen tan to yellow with variable dark markings; scutum with integumental pattern of 4 longitudinal bars; scutellum brownish yellow, narrowly margined with dark at base; legs tan to yellow, femora variously marked with dark brown; wing pattern with 3 separate transverse bands; anterior and posterior apical bands complete and unbroken; accessory costal bar present; abdominal tergites variously marked with brown to dark brown, with yellowish transverse marginal fasciae; apical process of glans short, bare, tunica with many spicules, especially basally; spermatheca spherical.

Discussion.--The three species comprising the ferruginea group are remarkably alike morphologically in having brown rather than black bodies, spherical spermathecae, similar wing patterns, and rather similar postabdomens in both males and females. Map 4 shows an interesting crescentic distribution, but it must be remembered that collections from Brazil and Argentina examined in this study were limited in size and scope, so that the distribution of these species, especially ferruginea, is likely to be much more extensive than shown here. This is the only species group on the South American continent known to utilize any plants other than the Solanaceae as a food source (table 2).

Rhagoletis ferruginea Hendel

(Figs. 9, 22, 44, 53, 57, 63, 68, 85; map 4)

Rhagoletis ferruginea Hendel 1927: 64. Type-locality, Santa Cruz, Brazil.--Lima 1934: 139 (collection note).--Aczél 1951: 271 (redescription, distribution); figs. 27-34 (head, abdomen, genitalia); unnumbered plate, fig. C (wing).--Aczél 1952: 118 (in neotropical catalog).--Aczél 1954: 77 (in key, neotropical species).--Bush 1966: 450, 451 (taxonomy).--Foote 1967: 57.40 (in neotropical catalog).--d'Araújo e Silva et al. 1968: 585 (hosts, references).

Diagnosis.--Body yellow to light brown, legs yellow; cheek relatively wide; face in profile prominently bowed outwardly and easily visible; scutal pattern (fig. 22) consisting of 4 wide longitudinal bars on light-brown background, none of them united anterior to transverse suture, separated by narrow light-brown bands; notopleuron and other pleural sclerites yellow; legs with normal proportions, not especially slender; ventral setae of forefemur heaviest and longest apically; midfemur with row of distinct setulae on anterior surface; hindtibia with subapical darkening; anterior apical band of wing pattern (fig. 85) distinctly narrower than hyaline area posterior to it; abdominal tergites yellow, tergites IV and V in male and V and VI in female with dark lateral spots.

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Description.--In profile, head about 1.6 times as high as long (fig. 9), gena about 0.22 times as high as eye, gena yellow, slightly extended anteriorly to face, setulae black anterior to bristle; face easily visible in lateral view, prominently bowed anteriorly between antennal bases and oral margin; antennal fossae deep, attaining oral margin; frons yellow, about 1.1 times as long as wide at ocellar triangle, frontal setulae black and clearly contrasting with yellow of frons; all head bristles black; antenna yellow, about 0.5 times as long as face, apex of third segment drawn to distinct point anteriorly, segment not markedly narrowed at tip; entire thickened base of arista yellow. Thorax almost entirely yellowish brown, whitish stripe extending from, and including, humerus to base of wing, distinctly wider posteriorly than anteriorly; scutal pattern (fig. 22) consisting of 4 longitudinal bars running nearly entire length of scutum and narrowly separated along their entire length by brown stripes, lateral ones most prominent near transverse suture, median stripe expanding posteriorly into dark triangle that includes scutoscutellar suture and extreme base of scutellum; small dark spot on metathorax adjacent to and touching base of scutellum laterally, sometimes continued narrowly along scutoscutellar suture to median dark triangle. Legs yellowish brown, only dark markings consisting of indistinct dark cloud near apex of hindtibia on dorsal, anterior, and posterior surfaces; ventral setae of forefemur rather heavy, longest and nearly spinelike at apex and shorter and lighter basally; midfemur with distinct row of 10-12 short black setae on anterior surface which contrasts with recumbent shorter setae and yellow of femur; hindfemur not unusually slender, with 1-2 long black anteroventral subapical setae. Wing (fig. 85) pattern with 4 well-developed transverse bands, discal band not attaining posterior margin, subapical band ending rather broadly on posterior margin, narrowed immediately posterior to junction with posterior apical band; anterior and posterior apical bands present and complete; anterior apical band distinctly narrower than hyaline fascia posterior to it; subapical band wider between 2 apical bands than posterior to posterior apical band; accessory costal spot present. Abdomen largely yellowish brown; tergite I with central black spot, tergites II and III in male and II-IV in female yellow on basal half, and with transverse whitish band on apical 0.5 that is not or very little narrowed laterally; tergite IV in male and V in female with dark-brown lateral spots on anterior half, transverse whitish band on apical half; tergite V in male and VI in female with similar pair of dark-brown spots, but more extensive than on preceding tergites, whitish bands about 0.25-0.33 as wide as tergite; ovipositor complex moderately long (fig. 44), proportions of sheath:spined part of ovipositubus:unspined part of ovipositubus:ovipositor as 2.0:1.5:1.2:2.6; extreme ovipositor tip triangular (fig. 44), ovipositor about 1.6 mm long, internal projections united at about half length of ovipositor; spermatheca spherical (fig. 53), crowned with minute papillae; vesica of glans of aedeagus spined, especially near base, anterior projection bare and rather short and narrow (fig. 57); ejaculatory apodeme very narrow (fig. 63); prensisetae situated at about 0.5 length of surstylus (fig. 68).

Material examined.--BRAZIL: Nova Teutonia, 27°11'S 52°23'W, 300-500 m, F. Plaumann: 1 ♀, IV.1966; 1 ♂, X.1967; 1 ♂, II.1976; 1 ♂, III.1977 (FMNH, USNM). Mandirituba, Paraná, 14.I.1976, L. M. Fehn, molasses trap in peach tree; 1 ♀(No. 7), 1 ♂(No. 21) (USNM).

Discussion.--This brownish-yellow species is distinctive in the group and may be recognized by several characters (see table 6), principally by the col-

TABLE 6.--Differentiating morphological characters of species in *ferruginea* group

Character	*ferruginea*	*adusta*	*blanchardi*
Bars in scutal pattern	4	6	4
Uniting of scutal bars	None	None	2 on each side.
Preapical bar widest	In cell R3	At vein dm-cu	In cell R3.
Anterior apical bar	Narrow	Wide	Wide.
Setal row, middle femur	Present	Absent	Present.
Shape of hindfemur	Normal	Slender	Normal.
Number of spots on hind-tibiae.	1	2	1
Color pattern on abdominal tergum.	5 dark spots on yellow.	Dark with light transverse bands.	Dark with light transverse bands.

oration of its abdomen in both sexes. In contrast to both *adusta* and *blanchardi*, the abdominal tergum of *ferruginea* is yellow with dark lateral markings, and the thorax is completely yellow except for a dark spot on each side of, and contiguous with, the base of the scutellum. All the abdominal tergites of the other two species are completely dark brown to black except for marginal brown to yellow transverse bands, and although the pair of metanotal spots is present in both *adusta* and *blanchardi*, they are not as noticeable because they do not contrast as well with the otherwise much darker thorax. R. *ferruginea* may also be distinguished from these two dark species by the width of the anterior apical arm of the wing pattern (figs. 85-87). In *ferruginea*, this band is narrower in cell R3 than the hyaline fascia immediately posterior to it, whereas in both dark species it is fully as wide as the hyaline area at the location.

Although I have not been able to examine the type-material of this species, it is perfectly clear that Hendel's original description is that of this light-bodied species rather than one or both of the other two members of the group, and that it is an adequate description of the specimens before me. Aczél (1951) gave an accurate account of this particular taxon under the name *ferruginea*, so that the identity of the true *ferruginea* cannot be said to be in doubt at this time.

Biology and economic importance.--The literature (see Gomez, 1940) gives no indication that when this species is found in *Citrus*, it is of any economic importance. Most of the references either were not available to me or merely listed *Citrus* as one of the hosts. Angely (1971) listed more than 90 species of wild *Solanum* as being found in the State of São Paulo alone. Of these, about 10 bear the common name of joá or a variant of that name (see table 2). It is likely that one or more species of wild *Solanum* are the basic and origi-

nal hosts for ferruginea and that its occurrence in Citrus is either accidental or only occasional.

R. ferruginea is apparently the only neotropical Rhagoletis from which a parasite has been reared. Opius bellus Gahan (1930) was originally described as a parasite of Anastrepha fraterculus (Wiedemann) from the Canal Zone and is reported by Lima (1937, 1949) as occurring in Brazilian ferruginea.

Rhagoletis adusta, new species

(Figs. 10, 23, 45, 58, 64, 69, 86; map 4)

Diagnosis.--Body dark brown, legs yellowish brown; cheek relatively narrow; face in profile bowed anteriorly between antennal bases and oral margin; scutal pattern (fig. 23) consisting of 6 longitudinal bars, none of which are connected, lateral bars short and situated entirely posterior to transverse suture; notopleuron brown; dorsal half of pleuron brown, ventral half yellowish brown to yellow; legs, especially hindfemora, rather slender; ventral setae of forefemur longest and heaviest apically; midfemur without row of distinct anterior setulae; hindtibia with both subbasal and subapical darkening, these two marks usually connected on dorsal surface; anterior apical band of wing pattern (fig. 86) equal in width to hyaline fascia directly posterior to it; abdominal tergites dark brown to black with yellowish posterior margins.

Description.--In profile, head about 1.5 times as high as long (fig. 10), gena about 0.17 times as high as eye, darker yellow than face or gular region, normally rounded anteriorly adjacent to facial margin; face easily visible in lateral view, prominently bowed anteriorly between antennal bases and oral margin; antennal fossae deep, attaining oral margin; frons brownish yellow, about 1.1 times as long as wide at ocellar triangle, frontal setulae dark brown; all head bristles black; antenna yellow, about 0.55 times as long as face, third segment bluntly pointed, segment not markedly narrowed at tip; entire thickened base of arista yellow; eye straight or slightly concave along posteroventral margin. Thorax distinctly brown, sometimes rather darkly so, whitish stripe extending from, and including, humerus to wing base, distinctly wider posteriorly than anteriorly; scutal pattern (fig. 23) consisting of 4 longitudinal bars along nearly entire length of scutum, lateral bars terminating posterior to extreme anterior margin of scutum, none of bars connected to each other, but separated by rather dark narrow bands, additional light bar at extreme lateral margin of scutum posterior to transverse suture; median brown stripe expanding posteriorly into prominent dark triangle that includes scutoscutellar suture and about 0.25 of base of scutellum; small dark spot on metathorax immediately adjacent to lateral base of scutellum, sometimes continued narrowly to connect with median triangle. Legs yellowish brown to brown, only markings consisting of 2 dark clouds of brown subbasally and subapically on dorsal, anterior, and posterior surfaces, connected with slightly lighter brown cloud along dorsal margin; ventral setae of forefemur moderately heavy, apical ones spinelike and longest; midfemur without any visible row of outstanding setae on anterior surface; hindfemur rather slender, about 6 times as long as greatest width, with only 1 long black anteroventral subapical seta. Wing pattern (fig. 86) with 4 well-developed transverse bands,

discal band attaining posterior margin, subapical band ending broadly on posterior margin of wing and widest at vein dm-cu; anterior and posterior apical bands complete, anterior apical band clearly as wide at apex of vein R4+5 as hyaline fascia immediately posterior to it, subapical band no wider along vein R2+3 than along vein R4+5; accessory costal spot present. Abdomen largely very dark brown to black; tergites II-IV in male and II-V in female each with transverse yellowish-brown fascia on posterior margin which is distinctly wider at midline than laterally; tergites V in male and VI in female with transverse bands narrower but distinct; ovipositor complex rather short (fig. 45), proportions of sheath:spined part of ovipositubus:unspined part of ovitubus:ovipositor as 2.0:1.2:1.2:2.4; ovipositor about 1.4 mm long, its tip simple, its sides gradually rounded to point (fig. 45), internal projections united rather close to ovipositor base; spermatheca spherical, crowned with minute papillae; vesica of glans of aedeagus (fig. 58) rather heavily spined, anterior projection wide at base, unspined; ejaculatory apodeme (fig. 64) with wings along basal stalk; prensisetae situated at about 0.6 length of surstylus (fig. 69).

Holotype.--Female, Cantareira, Chapadão, São Paulo, Brazil, Barreto coll. (MZSP).

Paratypes.--2 ♀♀, 2 ♂♂, same data as holotype (1 ♀, 1 ♂ (USNM); 1 ♀, 1 ♂ (MZSP)).

Discussion.--Both adusta and blanchardi may be distinguished from ferruginea by several characters (see table 6), principally by the dark abdominal tergum in both those species (see discussion of ferruginea for this and other differences). R. adusta differs in several respects from blanchardi, the other dark-bodied member of the ferruginea group. The scutal pattern with its six longitudinal bars, none of which are united, contrasts with that of blanchardi with its four bars, the two on each side united with each other anterior to the transverse suture. In further contrast to blanchardi, the anterior surface of the midfemur of adusta has no setal comb, the preapical bar of the wing pattern is widest at crossvein dm-cu rather than between the anterior and posterior bars, the hindfemur is rather slender, and two dark spots, rather than one, are on the dorsal, anterior, and posterior surfaces of the hindtibia subapically and subbasally. The species is known only from its type-locality (map 4).

Biology.--I have not been able to find any information on the biology or host relationships of this species.

Etymology.--The name adusta is the feminine gender form of the Latin adjective adustus, meaning tanned, brown, or swarthy, which is indicative of the general body color of this species.

Rhagoletis blanchardi Aczél

(Figs. 11, 24, 46, 59, 65, 70, 87; map 4)

Rhagoletis blanchardi Aczél 1954: 77 (in key, neotropical species); 78 (description); figs. 1-8 (head, male genitalia, ovipositor, female abdomen); pl.

1, A (wing). Type-locality, Urundel, Salta, Argentina.--Foote 1967: 57.40 (in neotropical catalog).

Diagnosis.--Body dark brown, legs yellowish brown; cheek relatively narrow; face in profile bowed anteriorly between antennal bases and oral margin; scutal pattern (fig. 24) consisting of 4 wide long bars on dark-brown background, 2 lateral bars on each side connected to each other anterior to transverse suture; notopleuron yellow; pleuron largely brown; legs with normal proportions, not especially slender; ventral setae of forefemur longest and heaviest at middle of row; midfemur with row of distinct setulae on anterior surface; anterior apical band of wing pattern (fig. 87) equal in width to hyaline fascia directly posterior to it; abdominal tergites dark brown to black with yellow posterior margins.

Description.--In profile, head about 1.6 times as high as wide (fig. 11), gena about 0.20 times as high as eye, dark yellow, with suggestion of even darker spot below eye, normally rounded anteriorly adjacent to facial margin; face easily visible in lateral view, prominently bowed anteriorly between antennal bases and oral margin; antennal fossae deep, attaining oral margin; frons brown, about 1.2 times as long as wide at ocellar triangle; frontal setulae brown, not contrasting well with color of frons; all head bristles black; antenna brownish yellow, about 0.5 times as long as face, third segment rather sharply pointed apically, segment rather triangular in shape; entire thickened base of arista yellow; posteroventral margin of eye normally rounded. Thorax distinctly dark brown, yellowish stripe extending from, and including, humerus to base of wing, distinctly wider posteriorly than anteriorly; scutal pattern (fig. 24) consisting of 4 longitudinal bars along entire length of scutum, 2 lateral ones on each side joined anterior to transverse suture, bars separated by dark-brown longitudinal stripes, 1 along midline expanded into dark triangle which is concolorous and contiguous with dark area at scutoscutellar suture and base of scutellum; small dark spot on metathorax immmediately adjacent to lateral base of scutellum, sometimes continued narrowly to connect with median triangle; scutellum about half black, half yellowish brown. Legs yellowish brown to brown, only dark markings consisting of clouded dark-brown area subapically on dorsal, anterior, and posterior surfaces of hindtibia; ventral setae of forefemur relatively heavy, spinelike and longest near middle of row; midfemur with row of 6-10 outstanding black setae on anterior surface; hindfemur not unusually slender, with 2-3 long black anteroventral subapical setae. Wing pattern (fig. 87) with 4 well-developed transverse bands, discal band not attaining posterior margin, subapical band ending broadly on posterior margin of wing, distinctly wider in cell R3 than in cell R5 and posteriorly; anterior and posterior apical bands complete, anterior band as wide as, or wider than, hyaline fascia immediately posterior to it at apex of vein R4+5; accessory costal spot present. Abdomen very largely dark brown to black, all tergites with yellowish-brown fascia on posterior margin which is wider at midline than at lateral margin, occupying about 0.20-0.25 width of each tergite; tergite V in male and VI in female sometimes only with triangular yellowish incision centrally on posterior margin; ovipositor (fig. 46) complex comparatively long, proportions of sheath:spined part of ovitubus:unspined part of ovitubus:ovipositor as 2.8:1.2:2.5:3.5; ovipositor about 2.2-2.3 mm long, its tip wedge shaped (fig. 46), internal projections united about 0.66 from ovipositor base; spermatheca missing; vesica of glans of aedeagus (fig. 59) distinctly spined, anterior pro-

jection very short and bare; ejaculatory apodeme without winged stalk (fig. 65); prensisetae situated at about 0.5 length of surstylus (fig. 70).

Material examined.--ARGENTINA: Paratypes: 1 ♀, Urundel, Salta, VI.1948, M. A. Rosillo, "criado de frutas de Citrus" (USNM); 1 ♂, Sierra de Córdoba, 8-13.I.1930, G. Williner S. J. (USNM). BOLIVIA: 3 ♀♀, 1 ♂, "temperate valley of Cochabamba, in traps," 1966, C. Montellano B. (USNM).

Discussion.--Both blanchardi and adusta may be recognized as distinct from ferruginea by several characters (see table 6), notably by the dark abdominal tergum in both these species (see discussion of ferruginea for this and other differences). R. blanchardi may be distinguished from adusta by several characters that have been discussed under the latter species and by additional features in the table. Map 4 shows its known distribution.

Biology.--Like ferruginea, blanchardi probably has one or more wild Solanum species as native hosts, even though it has been reported as having been reared from Citrus (see table 2).

RHAGOLETIS CINGULATA GROUP

Diagnosis.--Thorax and abdomen black with yellow markings; postocellars yellow; scutum with integumental pattern of 4 longitudinal bars; scutellum yellow with black base and sides; legs yellow, femora with extensive black markings; wing pattern with 3 separate transverse bands; anterior apical band (fig. 88) either forked at its apex or broken to form a separate spot at apex of vein R2+3; posterior apical band absent; accessory costal bar absent; abdominal tergites with yellowish transverse marginal fasciae; apical process of glans toothed, expanded, tunica bare; spermatheca rodlike.

Discussion.--According to Bush (1966), the cingulata group comprises four species, all confined to the conterminous United States and Canada (map 5). Bush's discussion of the group and its species is rather complete and is not repeated here. Until now the group was not thought to occur south of Texas, but specimens examined in this study and an account of a Mexican infestation by Padilla (1964) reveal the presence of the single species cingulata in that country.

Rhagoletis cingulata (Loew)

(Figs. 39, 88; map 5)

Trypeta cingulata Loew 1862: 76. Type-locality, "Middle States."
Rhagoletis cingulata (Loew): Bush 1966: 454 (in key, nearctic species); 473 (description); figs. 32 (head); 49, 50 (abdomen); 79, 111, 118, 152 (male genitalia); 168 (spermatheca); 203 (wing); 224 (chromosomes).--Bush 1969: 237 (hosts, biology, speciation).
Rhagoletis cingulata indifferens Curran: Padilla 1964: 9 (description of infestation, damage); figs. 1-5 (larva, pupa, adult).

Diagnosis.--Head 1.3 times as high as long, gena about 0.20 times as high

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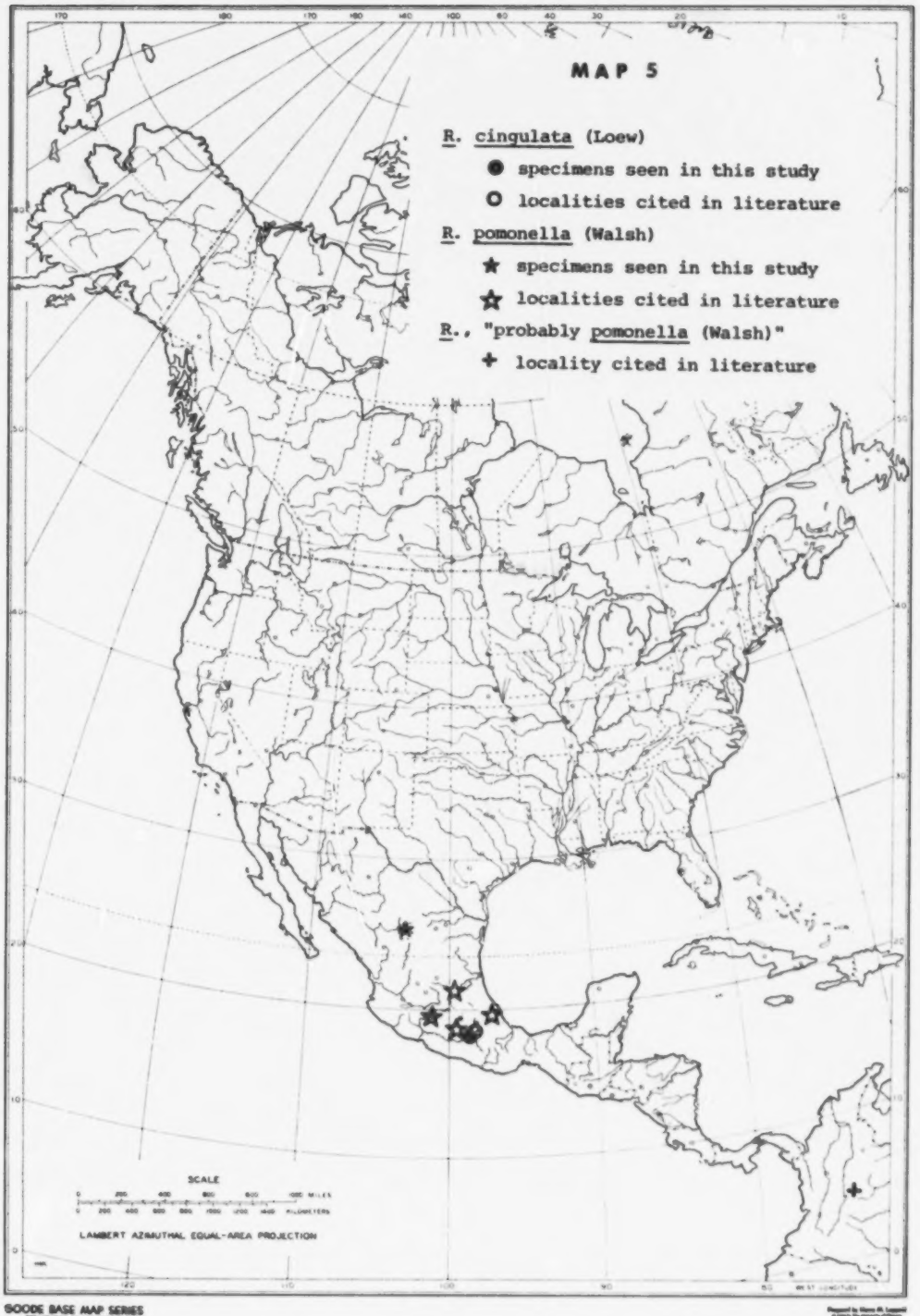

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as eye, genal bristle black; antenna 0.5-0.6 times as long as face, third segment drawn to distinct point apically; scutal pattern (fig. 39) of 4 longitudinal bars, 2 on each side of midline joined to each other anterior to transverse suture, all dark fasciae between them very narrow and with indistinct borders, 1 at centerline nearly disappearing at anterior margin of scutum; sides and basal third of scutellum black; femora highly variable, varying from all yellow to all nearly black; all tibia yellow; wing pattern (fig. 88) with all transverse bands present; discal band as wide as, or wider than, hyaline fasciae bordering it; anterior apical band either forked or anterior half of fork broken by hyaline fascia to costa, producing marginal spot in apex of cell R3; posterior apical arm absent; accessory costal spot absent; abdominal tergites II-IV in male and II-V in female with transverse whitish bands at posterior margins; tergite V in male and VI in female entirely dark, or with extremely narrow yellow posterior border.

Material examined.--1 ♀, 1 ♂, Tepetlixpa, Mexico, V.1977, C. Garcia Martell (USNM).

Biology and economic importance.--According to Wasbauer (1972), cingulata infests seven species of Prunus in the United States and Canada, among which black cherry (Prunus serotina Ehrh.) is the most important host. In his detailed study on this species, Bush (1966) stated that he had never found serotina infested in Mexico and doubted that cingulata occurred south of the Balcones escarpment in Texas. Berlocher (in litt.) indicated this species occurs so close to the U.S.-Mexico border that it must certainly occur in Mexico.

However, Padilla (1964) reported a Mexican infestation of what he identified as cingulata indifferens in Prunus serotina capuli (Cav.) subsp. McVaugh in Texcoco and several localities northwest of that city. He briefly described the damage to fruit, the extent and severity of the infestation, and described and illustrated the larva, pupa, and adult of this fly. Since the specimens seen in this study were collected from one of the localities mentioned by Padilla as being within the infested zone, I assume these two specimens represent the species involved in that infestation. They exhibit the characters of cingulata rather than of indifferens as described by Bush (1966), except that the anterior fork of the anterior apical band of the wing pattern is not isolated in a spot, a condition holding for more than two-thirds of the specimens of cingulata examined by Bush from several locations in the United States. It is not known whether this infestation is currently in existence and, if so, what threat it may pose to other fruit subject to attack by cingulata in Mexico.

RHAGOLETIS POMONELLA GROUP

Diagnosis.--Thorax and abdomen dark brown to black with yellow markings; postocellars yellow; scutum with integumental pattern of 4 longitudinal bars; scutellum yellow with black base and sides; legs yellow, femora with extensive black markings; wing pattern with only 2 distinct transverse bands, preapical rather wide; anterior apical band separated from costa along most of its length; posterior apical band complete; accessory costal bar absent; abdominal tergites with yellowish transverse marginal fasciae; apical process of glans elongate, long haired, tunica bare; spermatheca rodlike.

Discussion.--Bush (1966, 1969) discussed the origins, biology, and systematics of this group in detail. His work should be considered basic on these species, and I have not summarized his findings here. Of the four nearctic species comprising this group, pomonella is the only one known to occur south of the United States (map 5).

Rhagoletis pomonella (Walsh)

(Figs. 40, 89; map 5)

Trypeta pomonella Walsh 1867: 343, fig. 2 (adult dorsum). Type-locality, Illinois.

Rhagoletis pomonella (Walsh): Bush 1966: 454 (in key, nearctic species); 457 (description); figs. 25 (head); 45, 47 (dorsum); 71, 90, 113, 135 (male genitalia); 156 (spermatheca); 183 (ovipositor); 185, 186 (wings); 213, 214 (chromosomes); 241 (micropyle of egg).--Foote 1967: 57.41 (in neotropical catalog).--Bush 1969: 237 (hosts, biology, speciation).

Diagnosis.--Head about 1.3 times as high as long, gena about 0.17 times as high as eye, genal bristle yellow; antenna 0.7-0.8 times as long as face, third segment drawn to apical point; scutal pattern of 4 rather oblique longitudinal bars, 2 on each side united anterior to transverse suture, dark fascia on centerline rather narrow anteriorly, widening posteriorly where it is distinctly wider than dark fasciae separating lateral bars; scutellum usually dark on sides and basal half; capitate part of halter black, base yellow; femora yellow, or partly or entirely black except at extreme apices; all tibiae yellow; wing pattern (fig. 89) with discal and preapical bands very widely united and coursing diagonally across wing disk; anterior apical band separated from costa along most of its length; posterior apical band extending almost directly posterior across crossvein dm-cu; accessory costal spot absent; abdominal tergites II-IV in male and II-V in female with rather wide, prominent, whitish transverse marginal bands.

Material examined.--3 ♀♀, 2 ♂♂, Matamoros, Mexico, VI.1957, USDA Lot No. 37-19182, reared ex tejocote (Crataegus sp.) (USNM).

Discussion.--Probably the most destructive North American fruit fly, pomonella is limited in its distribution largely to the transitional zone of the United States and southern Canada east of the 100th meridian. It has the most literature of any nearctic tephritid (see Rivard, 1968). Bush (1966, 1969) discussed its origins, morphology, and biology in detail, and investigations into its interspecific relationships and habits are being pursued by several workers.

In Mexico the distribution of pomonella is not well known. It has been reared from species of Crataegus and from apple (Malus sylvestris Mill.) by Bush at the locations shown by the open stars in map 5 and from Crataegus sp. (tejocote) at Matamoros (see material examined). The specimens seen in this study are from a location much farther north, indicating that the species generally may be rather widespread in Mexico as is Crataegus, its primary native host. Reports of Crataegus haws and apples with what seem to be pomonella larvae have appeared in the literature (Benjamin, 1934; Bush, 1966), and the

Plant Quarantine operations of the Animal and Plant Health Inspection Service, U.S. Department of Agriculture, intercept larvae at its ports of entry several times each year. At least once pomonella was reported in an interception from Costa Rica; its identification was based on the larval stage. Bush (1966) indicated that apples are not grown commercially in Costa Rica but that Crataegus is common at high altitudes there. Unfortunately the origin of intercepted material is often in doubt, and it is generally unwise to depend entirely on species identifications based on immature stages alone.

Garcés and Luis (1947) reported an infestation of "probably pomonella" from manzano (apple) at Belencito near Medellín, Colombia. No additional information has been available either on the status of that infestation or on the exact identification of the Rhagoletis involved.

RHAGOLETIS SUAVIS GROUP

Diagnosis.--Thorax and abdomen yellow, or tan with various black markings, or entirely black; scutum never with integumental pattern, tan to black; scutum cream color without dark markings, or with very narrow dark mark basally; legs black to tan; wing pattern with 3 transverse bands except in juglandis, in which subbasal band is replaced by yellow area; anterior apical band complete or narrowed at base; posterior apical band incomplete to absent; additional brown markings may be present on vein R4+5 and in cell behind; accessory costal bar absent; abdominal tergites either completely yellow, or tan with variable dark markings, or black; yellowish to white transverse marginal fasciae usually present; apical process of glans short and bare, haired, or toothed; vesica bare; membraneous pouch present between genital ring and fultella; spermatheca rodlike.

Discussion.--The suavis group, comprising five species, is restricted entirely to the nearctic region (map 6). R. suavis (Loew) itself is found only in the United States north of about 33° N. latitude and east of the 100th parallel and is not discussed here. R. completa is primarily a western United States species with a probable distribution in northern Mexico. R. juglandis is found from northern New Mexico to central Mexico and possibly even farther south, whereas zoqui is entirely Mexican in distribution. R. boycei is restricted to Arizona and southwestern New Mexico and apparently occurs in northern Sonora.

Without exception, all members of the group infest various species of walnut (Juglans spp.; Juglandaceae) (table 2); thus they present a singular picture of syntrophy among American Rhagoletis species. Unlike the members of all other groups in the Americas, those belonging to the suavis group are related to each other more on the basis of their host relationships than on morphological similarities. Bush (1966, 1969) discussed all aspects of these species in considerable detail. Table 7 includes the outstanding morphological differences among the species known to occur, or suspected of occurring, in Mexico. None of the species in the group presents any economic problem, as they are not often seen in Mexico, although they may be potentially dangerous if found in large, intensive infestations.

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TABLE 7.--Differentiating morphological characters of species in *suavis* group [1/]

Character	*completa*	*juglandis*	*zoqui*	*boycei*
Gena/eye	About 0.30	About 0.20	About 0.15	About 0.18.
Genal bristle	Yellow	Yellow	Black	Black.
Color of pleuron	Variable, brown to black.	Tan, no dark markings	Black, or black spotted.	Do.
Metanotum	Banded or completely dark.	Tan	Banded	Do.
Transverse wing band	3	2	3	3
Anterior apical band	Parallel-sided	Narrowed at base	Narrowed at base	Parallel-sided.
Posterior apical band	Absent	On vein AM	On vein AM	On vein AM.
Abdominal tergites, male.	I-V tan, with dark shading.	I-V light cream color.	III-V tan, with dark marks.	Black.
Abdominal tergites female.	I-VI tan, with dark shading.	I-VI light cream color.	Tan, without dark marks.	Do.

[1/]From Bush (1964), supplemented by information from U.S. specimens in U.S. National Museum.

Rhagoletis completa Cresson

(Figs. 41, 90; map 6)

Rhagoletis suavis subsp. completa Cresson 1929: 412; pl. XVI, fig. 9 (wing). Type-locality, Chino, San Bernardino Co., Calif.
Rhagoletis completa Cresson: Bush 1966: 454 (in key, nearctic species); 488 (description); figs. 28 (head); 63, 64 (dorsum of body); 73, 97, 131, 145 (male genitalia); 158 (spermatheca); 192, 193 (wings); 220 (chromosomes).--Bush 1969: 237 (hosts, biology, speciation).--Wasbauer 1972: 126 (hosts).--Steyskal 1973: 552 (in key to larvae in walnuts).

Diagnosis.--Gena about 0.30 times as high as eye; genal bristle yellow; dark markings of pleural region in both sexes rather extensive, dark brown to black; metanotum with 2 narrow to broad dark bands, or completely dark; forefemur brown to black, midfemur tan, hindfemur tan to brownish black; foretibia and midtibia straw colored, hindtibia straw colored to brownish black; all transverse bands in wing pattern present (fig. 90); discal band distinctly wider than hyaline fasciae on each side of it, anterior apical band complete, not at all narrowed at its junction with preapical band; posterior apical band absent; abdominal tergites I-V in both sexes progressively darker posteriorly, tergites III and IV of male and III-IV in female with distinct pollinose cream-colored transverse bands on posterior margins, but tergite V in male and VI in female nearly entirely dark.

Discussion.--Bush (1966) indicated that this species may occur in extreme northern Mexico, probably near its extreme southern distribution in the United States. The only record known to me is an unpublished one sent by Stuart Berlocher. He collected this species from Juglans hirsuta Manning at Horsetail Falls near Monterrey, Mexico, in 1975. Its wing pattern (fig. 90) is distinctive among Mexican members of the suavis group in that the anterior apical band is complete rather than narrowed or interrupted at its connection with the preapical band, and the dark trace of the posterior apical band along vein M is entirely absent. Bush (1966, 1969) described and discussed this species in detail.

Rhagoletis juglandis Cresson

(Figs. 42, 91; map 6)

Rhagoletis juglandis Cresson 1920: 65. Type-locality, Carr Canyon, Huachuca Mts., Ariz.--Bush 1966: 454 (in key, nearctic species); 490 (description); figs. 31 (head); 72, 99, 130, 142 (male genitalia); 160 (spermatheca); 195 (wing); 221 (chromosomes).--Foote 1967: 57.41 (in neotropical catalog).--Bush 1969: 237 (hosts, biology, speciation).--Wasbauer 1972: 128 (hosts).--Steyskal 1973: 522 (in key to larvae in walnuts).

Diagnosis.--Gena about 0.20 times as high as eye; genal bristle yellow; only dark markings are pair of dark spots, 2 immediately above each wing base, on pleuron; metanotum entirely light tan, without darker markings; male and female without any dark markings on any of the legs; subbasal transverse band of wing pattern represented only by yellowish streak in place of usual dark

band (fig. 91); discal band much narrower than hyaline fascia immediately distal to it; anterior apical band distinctly narrowed or completely interrupted at its junction with preapical band, but widening markedly into tip of cell R5, where rounded hyaline spot is usually present; posterior apical band represented by dark continuation of anterior apical band toward vein dm-cu along vein AM; dark spot usually present on vein R4+5 in center of apicalmost hyaline fascia; all abdominal tergites light cream color without any dark marks, faint whitish transverse marginal band on each of tergites II-IV of male and II-V of female.

Discusssion.--According to Bush (1966), the range of juglandis extends from Utah to central Mexico and possibly even farther south, as the genus Juglans occurs well into Central America. Bush reared the species from Juglans major in Durango (table 2). This species most closely resembles zoqui in its general coloration and wing pattern, but it can be distinguished from the latter species by the characters given in table 7. It is the only member of the suavis group with the combination of a yellow genal bristle and the metanotum and abdomen of both sexes completely devoid of dark brown to black markings. The wing pattern (fig. 91) is also distinctive among all American Rhagoletis species in that the subbasal transverse band, rather than being distinct, is represented only by an ill-defined yellow area. Bush (1966, 1969) described and discussed this species in detail.

Rhagoletis zoqui Bush

(Figs. 43, 92; map 6)

Rhagoletis zoqui Bush 1966: 454 (in key, nearctic species); 493 (description); figs. 29 (head); 61, 62 (thorax, abdomen); 78, 98, 133, 143 (male genitalia); 159 (spermatheca); 196 (wing); 223 (chromosomes). Type-locality, Zacualtipán, Hidalgo, Mexico.--Foote 1967: 57.41 (in neotropical catalog).--Bush 1969: 237 (hosts, biology, speciation).

Diagnosis.--Gena about 0.15 times as high as eye; genal bristle black; pleuron predominantly black in male, tan with isolated black patches in female; metanotum with 2 reddish-brown, broad, vertical bands; none of legs with any dark markings in female; forefemur and midfemur black at base, grading to yellowish orange at extremities; hindfemur, foretibia, and midtibia dark tan or black at base, grading to tan at apex; hindtibia black at base, grading to orange yellow at apex; wing pattern (fig. 92) with all transverse bands present; discal band somewhat wider than narrowest part of hyaline fascia immediately distal to it; anterior apical band distinctly narrowed at its junction with subapical band, widening into apex of cell R5; oval dark spots on vein R5 near base of anterior apical band in cell R5 immediately behind it; posterior apical band a continuation of anterior apical band along apical two-thirds of vein AM; abdominal tergites I-VI of female without dark markings, tergites I and II of male without dark marks, tergite III with pair of dark ovoid spots, tergites IV and V almost entirely dark.

Material examined.--Paratypes, 1 ♀, 1 ♂, Zoquizoquipan, Hidalgo, Mexico, 29.X.1960, G. L. Bush (USNM).

Discussion.--R. zoqui was reared at Zacualtipán and Zoquizoquipan, Hidalgo, Mexico, by G. L. Bush (1966) from Juglans mollis, a species of walnut completely restricted to Mexico. As it is the only recorded host for zoqui and as no other Rhagoletis species has been found using it as a host, zoqui is regarded as being not sympatric with any other species of the suavis group. Surprisingly enough, zoqui most closely resembles boycei, whose known range is rather far removed from the type-locality of the former species. It can be distinguished from other suavis group species by its banded metanotum, the narrowed base of the anterior apical band and the presence of an isolated dark streak in cell R5 of its wing pattern, and the tan ground color of its abdomen in both sexes (see also table 7). To my knowledge, zoqui has not been collected since it original rearing by Bush, who described and discussed it in detail (1966, 1969).

Rhagoletis boycei Cresson

(Fig. 93; map 6)

Rhagoletis boycei Cresson 1929: 413; pl. XVI, fig. 10 (wing). Type-locality, Carr Canyon, Huachuca Mts., Cochise Co., Ariz.--Bush 1966: 454 (in key, nearctic species); 492 (description); figs. 27 (head); 65, 66, 76, 95, 132, 144 (male genitalia); 161 (spermatheca); 194 (wing); 222 (chromosomes).--Bush 1969: 237 (hosts, biology, speciation).

Diagnosis.--Gena about 0.18 times as high as eye; genal bristle black; entire thorax black except pleural stripe, halter, and scutellum, latter tinged with black basally; all femora black except at apices; foretibia and midtibia yellow with black shading, hindtibia black to yellow; wing pattern (fig. 93) with all transverse bands present; anterior apical band complete, not interrupted or narrowed at base; posterior apical band a continuation of anterior apical band along apical two-thirds of vein AM; abdominal tergum black, tergites II-IV in male and II-V in female with yellowish to white transverse marginal bands.

Discussion.--R. boycei is a relatively rare species with a more or less restricted distribution in Arizona and southwestern New Mexico. In the United States it has been reared from Juglans major (Torr.) Heller and an unnamed variety of Juglans regia L., but its specific walnut hosts in Mexico are not known. It is reported by Bush (1966) to occur in northern Sonora, but I have not been able to examine any Mexican specimens. It is the only completely dark-brown to black species in the suavis group, and thus it more closely resembles species of the nova, striatella, pomonella, and cingulata groups in this respect. However, it may be distinguished from all the other dark-bodied Rhagoletis species by its distinctive wing pattern (fig. 93), in which the posterior apical band is represented by a continuation of the anterior apical band along vein M toward the preapical transverse band. It can easily be distinguished from juglandis and zoqui by the absence of isolated dark streaks on vein R2+3 and in cell R5 in addition to its dark thorax and abdomen. Bush (1966, 1969) described and discussed this species in detail.

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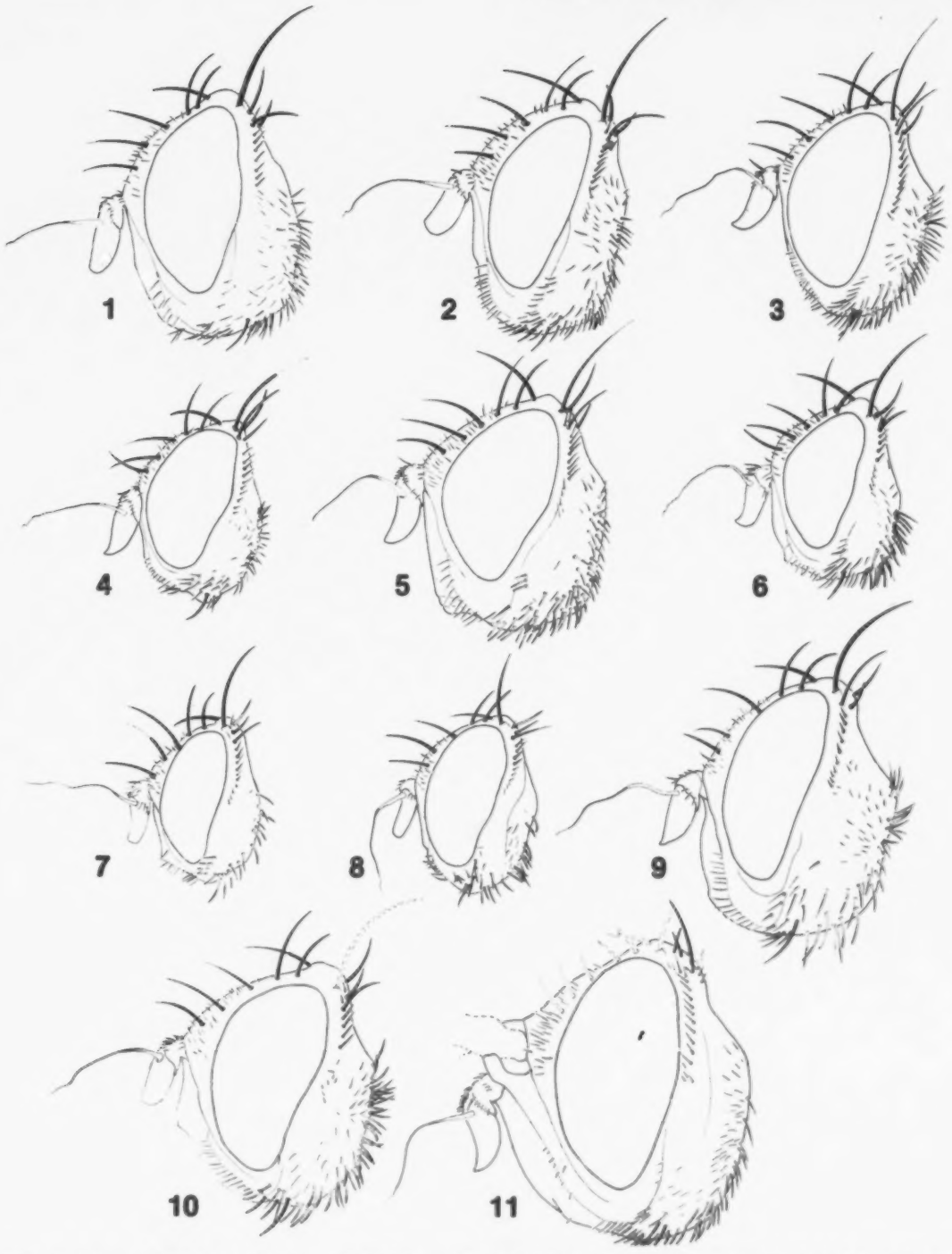

Figures 1-11.--Lateral view of heads, Rhagoletis spp.: 1, lycopersella Smyth; 2, tomatis, n. sp.; 3, nova (Schiner); 4, penela, n. sp.; 5, psalida Hendel; 6, rhytida Hendel; 7, macquartii (Loew); 8, jamaicensis, n. sp.; 9, ferruginea Hendel; 10, adusta, n. sp.; 11, blanchardi Aczél.

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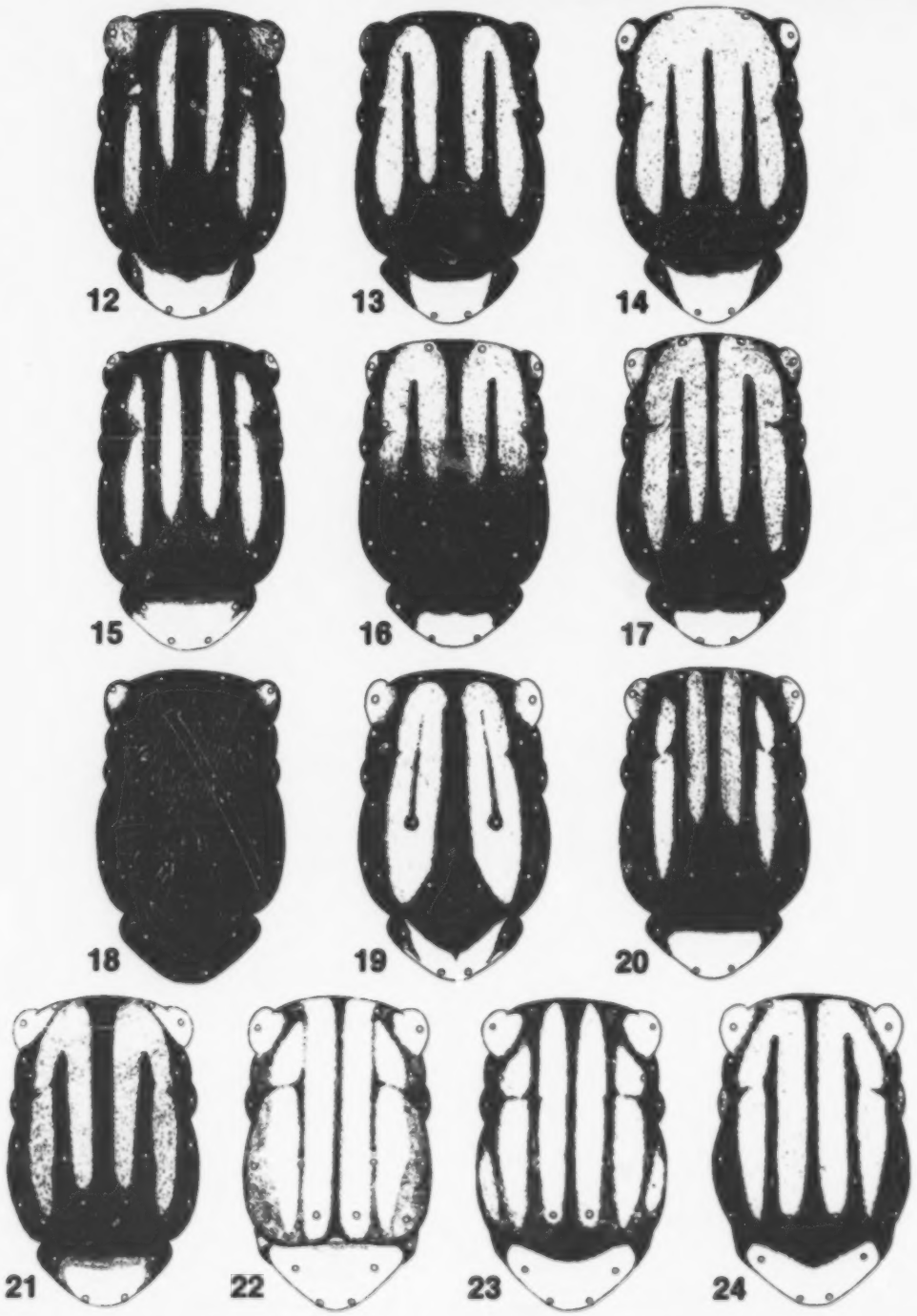

Figures 12-24.--Dorsal view of scuta and scutella, Rhagoletis spp.: 12, lycopersella Smyth; 13, tomatis, n. sp.; 14, nova (Schiner); 15, conversa (Brèthes); 16, willinki Aczél; 17, penela, n. sp.; 18, psalida Hendel; 19, striatella Wulp; 20, macquartii (Loew); 21, jamaicensis, n. sp.; 22, ferruginea Hendel; 23, adusta, n. sp.; 24, blanchardi Aczél.

Figures 25-27.--Dorsal view of abdomens, Rhagoletis spp.: 25, tomatis, n. sp.; 26, psalida Hendel; 27, striatella Wulp.

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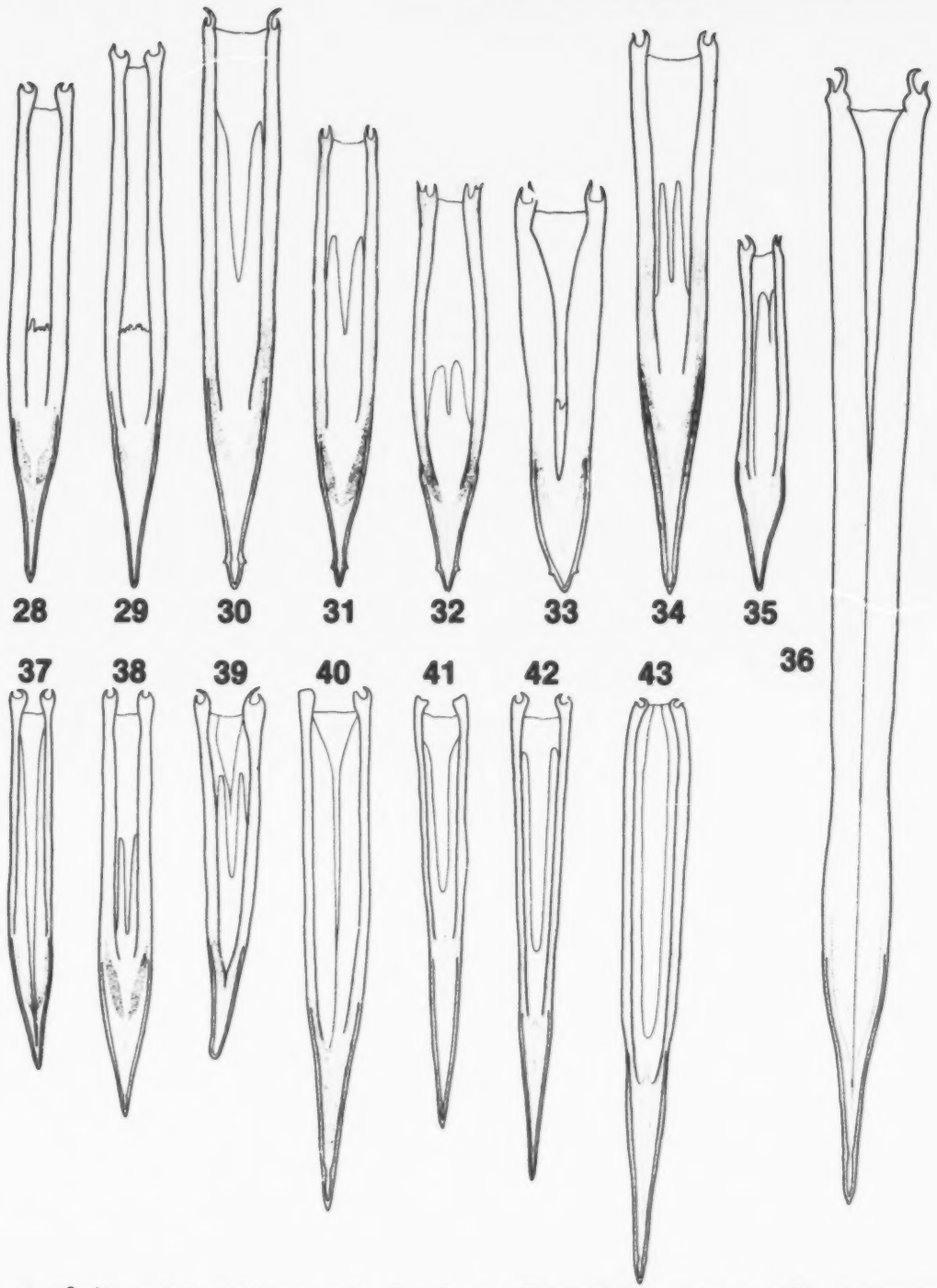
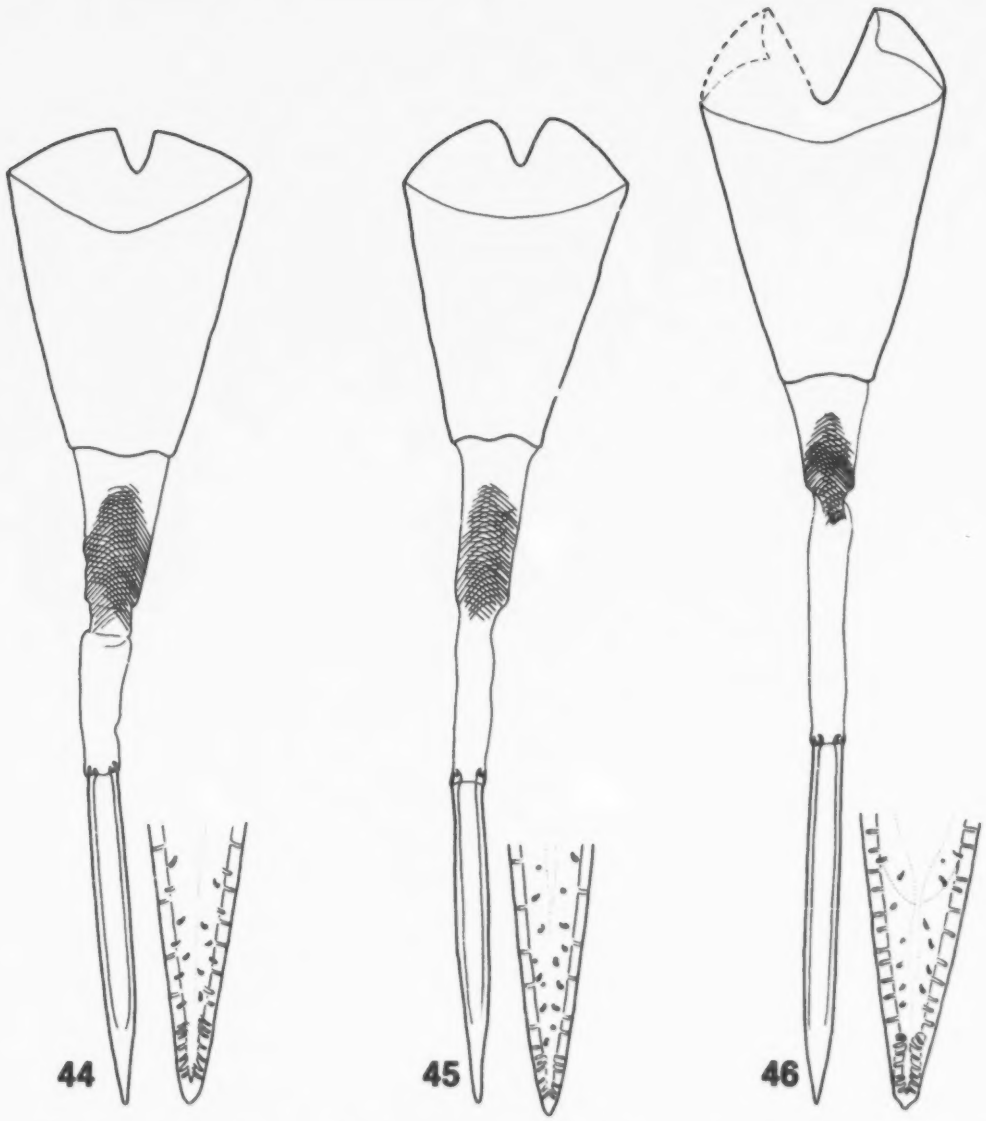


Figures 28-43.--Ovipositors of females, Rhagoletis spp.: 28, lycopersella Smyth; 29, tomatis, n. sp.; 30, nova (Schiner); 31, conversa (Brèthes); 32, willinki Aczél; 33, penela, n. sp.; 34, psalida Hendel; 35, rhytida Hendel; 36, striatella Wulp; 37, macquartii (Loew); 38, jamaicensis, n. sp.; 39, cingulata (Loew); 40, pomonella (Walsh); 41, completa Cresson; 42, juglandis Cresson; 43, zoqui Bush.



Figures 44-46.--Ovipositor sheaths, ovipositubi, and ovipositors (left) and ovipositor tips (right), Rhagoletis spp.: 44, ferruginea Hendel; 45, adusta, n. sp.; 46, blanchardi Aczél.

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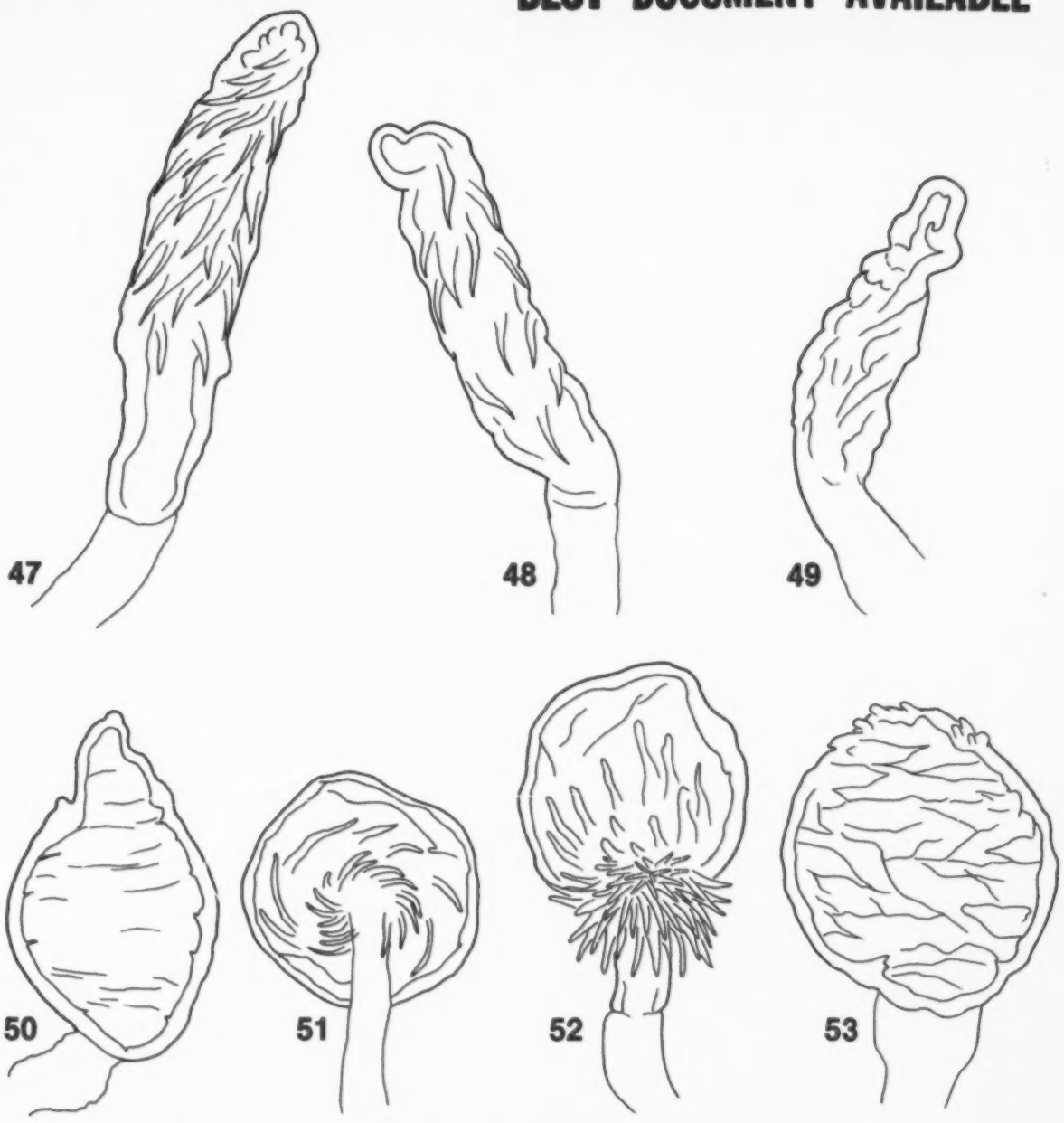
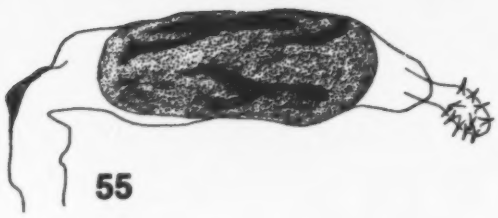
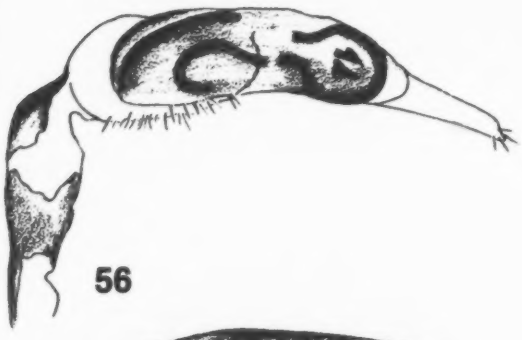
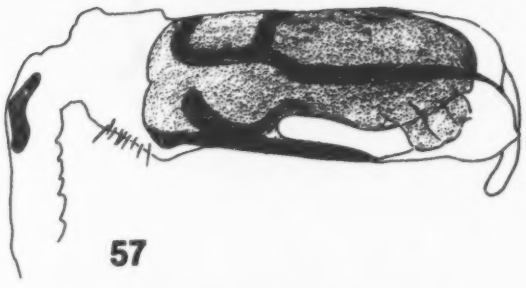
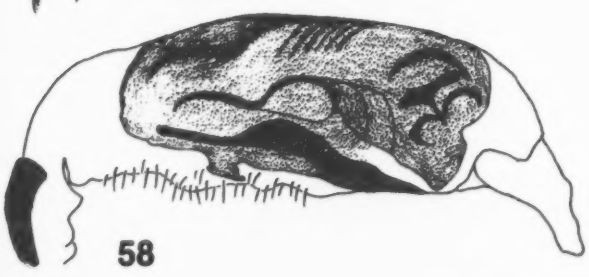


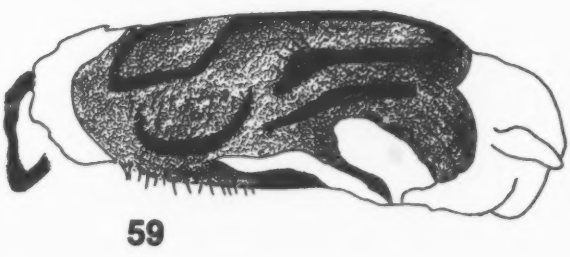
Figures 47-53.--Spermathecae, Rhagoletis spp.: 47, tomatis, n. sp.; 48, psalida Hendel; 49, rhytida Hendel; 50, striatella Wulp; 51, macquartii (Loew); 52, jamaicensis, n. sp.; 53, ferruginea Hendel.











Figures 54-59.--Aedeagi, Rhagoletis spp.: 54, lycopersella Smyth; 55, tomatis, n. sp.; 56, psalida Hendel; 57, ferruginea Hendel; 58, adusta, n. sp.; 59, blanchardi Aczél.

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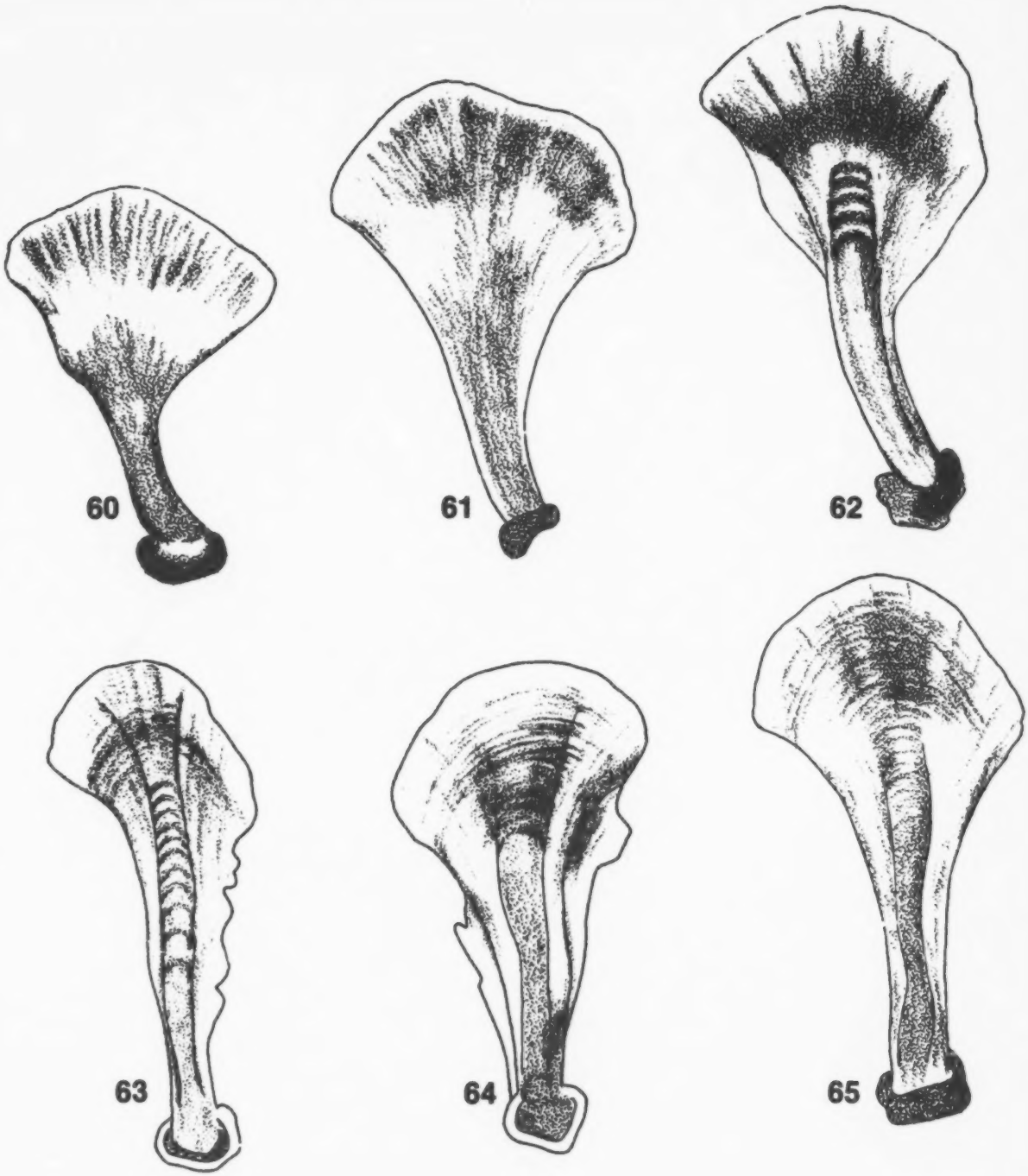

Figures 60-65.--Ejaculatory apodemes, Rhagoletis spp.: 60, lycopersella Smyth; 61, tomatis, n. sp.; 62, psalida Hendel; 63, ferruginea Hendel; 64, adusta, n. sp.; 65, blanchardi Aczél.

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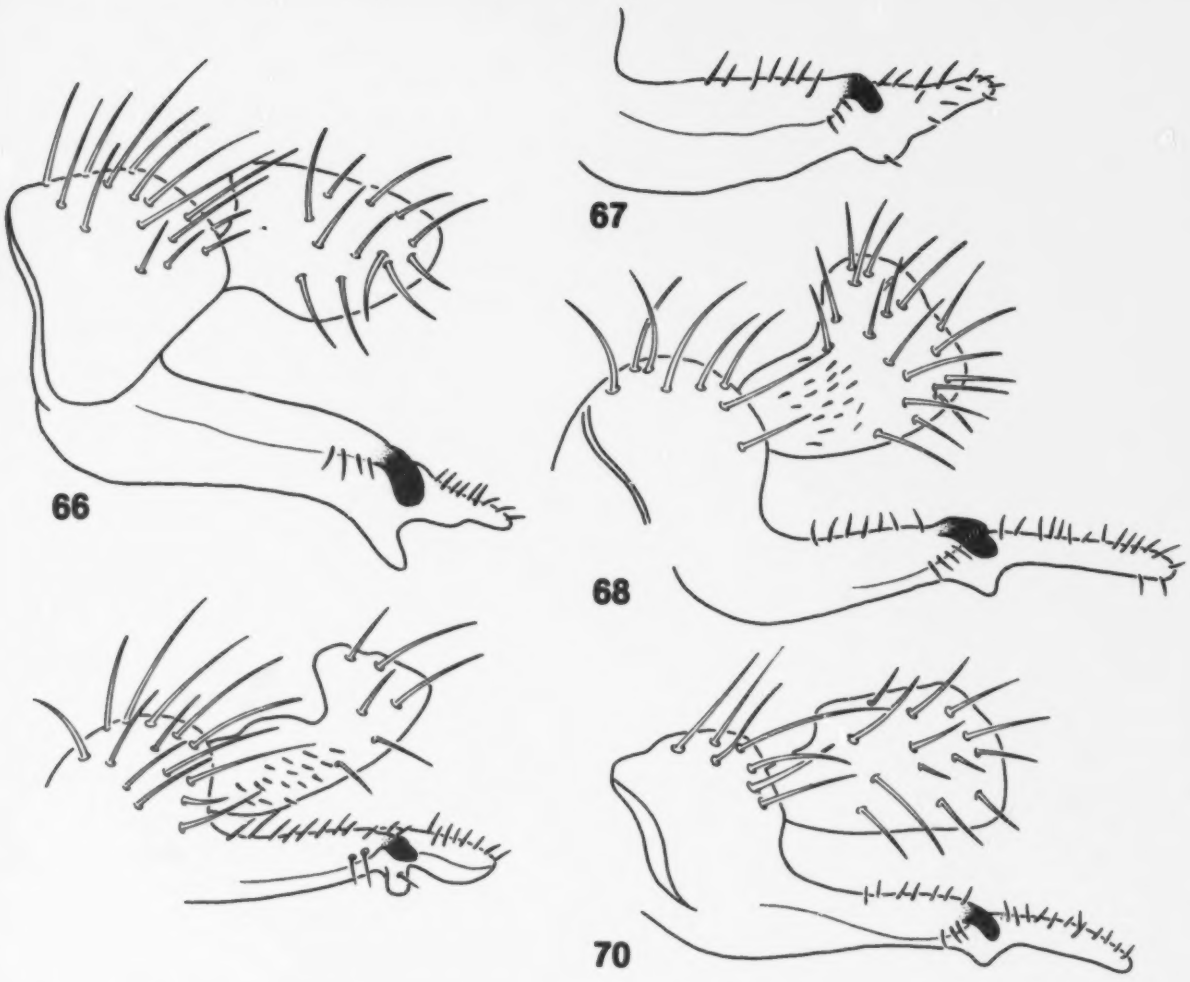

Figures 66-70.--Lateral view, surstyli, Rhagoletis spp.: 66, lycopersella Smyth; 67, psalida Hendel; 68, ferruginea Hendel; 69, adusta, n. sp.; 70, blanchardi Aczél.

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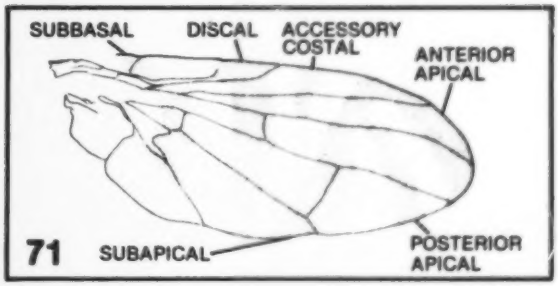

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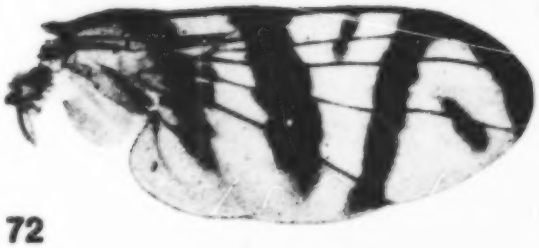

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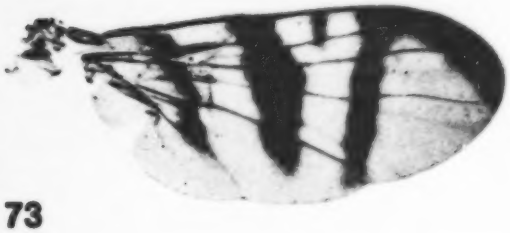

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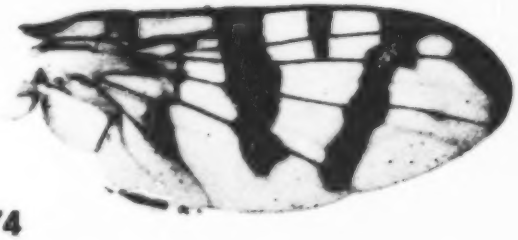

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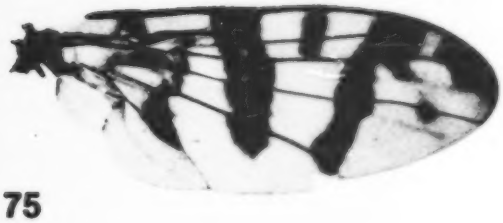

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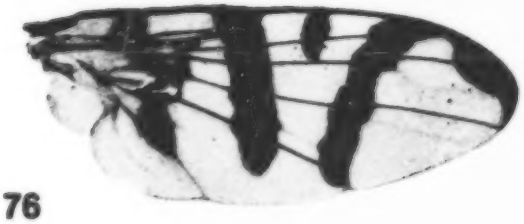

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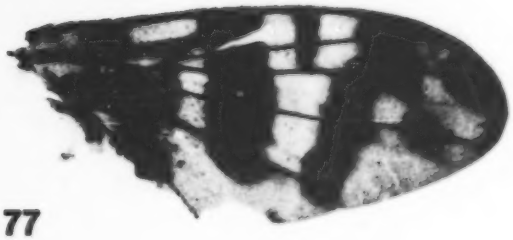
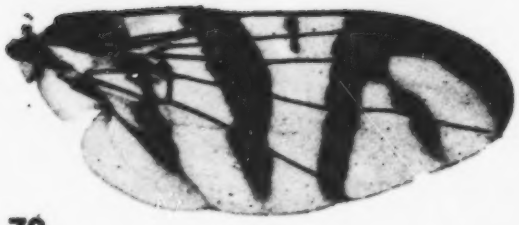


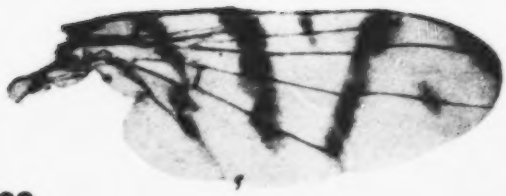
77

78

Figures 71-78.--Right wings, Rhagoletis spp.: 71, Species of ferruginea group, showing names of wing bands; 72, lycopersella Smyth; 73, tomatis, n. sp.; 74, nova (Schiner) (typical); 75, nova (Schiner) (atypical); 76, conversa (Brèthes); 77, willinki Aczél; 78, penela, n. sp.



79



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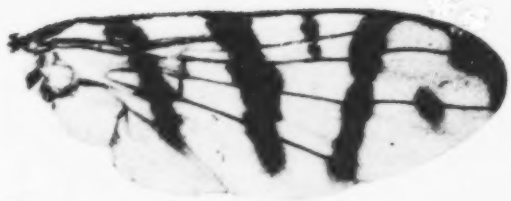
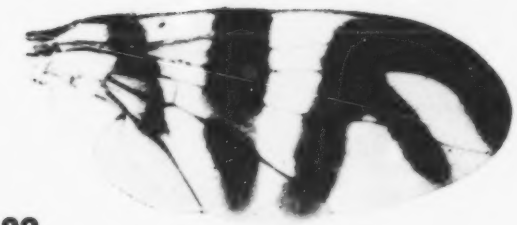


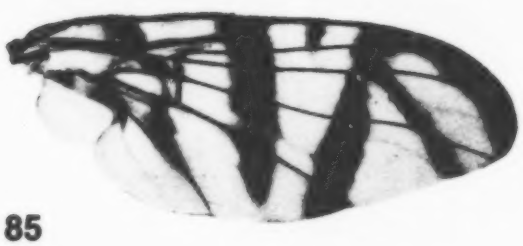
81



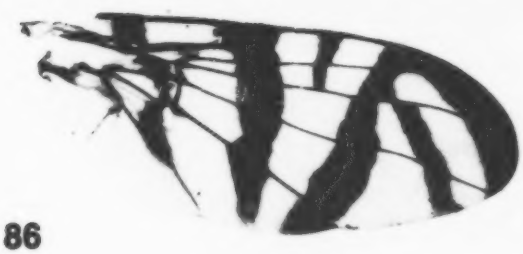
82

83

84



85



86

Figures 79-86.--Right wings, Rhagoletis spp.: 79, psalida Hendel (typical); 80, psalida Hendel (Bolivia); 81, rhytida Hendel; 82, striatella Wulp; 83, macquartii (Loew); 84, jamaicensis, n. sp.; 85, ferruginea Hendel; 86, adusta, n. sp.

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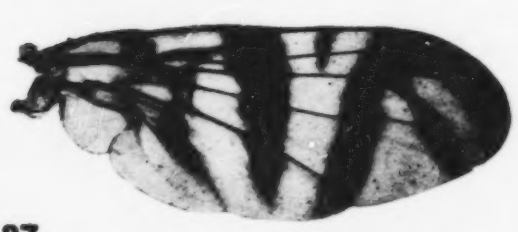

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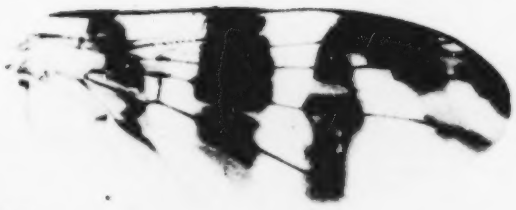

88

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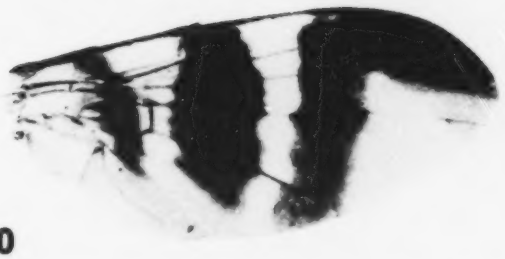
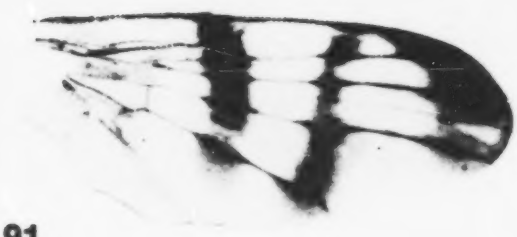


90



91

92

93

Figures 87-93.--Right wings, Rhagoletis spp.: 87, blanchardi Aczél; 88, cingulata (Loew); 89, pomonella (Walsh); 90, completa Cresson; 91, juglandis Cresson; 92, zoqui Bush; 93, boycei Cresson.

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INDEX TO INSECT AND PLANT NAMES

achraspis [sic] (Wiedemann), 18
adusta, n. sp., 11, 45
Anastrepha fraterculus
  (Wiedemann), 45
apple, 7
aurantium L., Citrus, 7

bellus Gahan, Opius, 45
black cherry, 50
blanchardi Aczél, 11, 46
boycei Cresson, 10, 57

capuli (Cav. ex Spreng.) McVaugh,
  Prunus serotina subsp., 7, 50
capulin, 7
cherry, black, 50
cingulata group, 10, 48
cingulata indifferens Curran, 48
cingulata (Loew), 10, 48
Citrus, 44
Citrus aurantium L., 7
Citrus sinensis (L.) Osb., 7
Citrus sp., 7
completa Cresson, 11, 55
conversa Brèthes, 9, 22
Crataegus spp., 7, 51
cucumber, sweet, 6
cultivated tomato, 6
currant tomato, 6

dulce, pepino, 6

encarcelada, nogal, 8
esculentum Mill.,
  Lycopersicon, 6

ferruginea group, 10, 41
ferruginea Hendel, 11, 41
fraterculus (Wiedemann),
  Anastrepha, 45

hawthorn, 7
hirsuta Manning, Juglans, 7, 55
husk-tomato, 6

indifferens Curran, 48

jamaicensis, n. sp., 10, 39
joá, 7
juglandis Cresson, 11, 55
Juglans hirsuta Manning, 7, 55
Juglans major (Torr.) Heller, 7, 56, 57
Juglans mollis Engelm., 8, 57
Juglans regia L., 57
Juglans sp., 7, 8

laranja, 7
lycopersella Smyth, 9, 15
Lycopersicon esculentum Mill., 6
Lycopersicon pimpinelli-
  folium (L.) Mill., 6

macquartii (Loew), 10, 37
major (Torr.) Heller, Juglans, 7, 56, 57
Malus sylvestris Mill., 7, 51
manzano, 7
meca, nuez, 8
metallica Hendel, 10, 33
mollis Engelm., Juglans, 8, 57
muricatum Ait., Solanum, 6

nogal, 8
nogal encarcelada, 8
nova group, 9, 13
nova (Schiner), 9, 20
nuez meca, 8
nuez pecanero, 8

ochraspis Wiedemann, 11
ochrastis [sic] (Wiedemann), 20
Opius bellus Gahan, 45
orange, 7
orange, sour, 7

pecanero, nuez, 8
penela, n. sp., 9, 26
pepino, 6
pepino dulce, 6
Physalis spp., 6
pimpinellifolium (L.) Mill.,
  Lycopersicon, 6
pomonella group, 10, 50
pomonella (Walsh), 10, 51

potato, 6
Prunus serotina Ehrh., 50
Prunus serotina subsp. capuli (Cav. ex Spreng.) McVaugh, 7, 50
Prunus sp., 50
psalida group, 9, 27
psalida Hendel, 10, 28

regia L., Juglans, 57
rhytida Hendel, 10, 31

serotina Ehrh., Prunus, 50
serotina subsp. capuli (Cav. ex Spreng.) McVaugh, Prunus, 7, 50
sinensis (L.) Osb., Citrus, 7
Solanaceae, 5
Solanum muricatum Ait., 6
Solanum spp., 7
Solanum tuberosum L., 6
sour orange, 6
striatella group, 10, 34
striatella Wulp, 10, 34
suavis group, 10, 11, 52
suavis (Loew), 52
sweet cucumber, 6
sylvestris Mill., Malus, 7, 51

tejocote, 7
tomate, 6
tomatillo, 6
tomatis, n. sp., 9, 18
tomato, cultivated, 6
tomato, currant, 6
tomato, husk, 6
tomato, wild, 15
tuberosum L., Solanum, 6

walnut, 7
wild tomato, 15
willinki Aczél, 9, 24

Zonosemata Benjamin, 37
zoqui Bush, 11, 56